A Vital Knowledge System

Dutch research with a view to the future

Foresight Steering Committee

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Dutch research with a view to the future

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Foresight Steering Committee

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The Foresight Steering Committee was established by the Minister of Education and Science to promote foresight studies into the strategic significance of research in the long term. These studies are conducted in various fields of science and technology. The Foresight Steering Committee then uses the results of these studies to formulate options for research institutes and stakeholders in Dutch society as well as for the government's science policy.
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PREFACE

The Netherlands has a need for knowledge. Knowledge to further develop our society. Knowledge to reinforce our economy and our level of employment. Knowledge to keep our culture alive. It is our intention to keep it that way. Nevertheless, the magnitude of scientific research calls for well-considered choices to be made: in which areas should the Dutch Government and the Dutch research community make investments, both in time and in money? This was the reason for the Foresight Steering Committee's establishment in 1992; to offer a perspective for a vital research system for the next ten years and to increase, where possible, the effectiveness of collective expenditure on research. Targeted investments also have another effect. By combining research well with investments in equipment, machinery, roads or ports for instance, we can increase the effectiveness of our material investments.

This Foresight Steering Committee report comes at a very opportune time as it helps stimulate the *National Knowledge Debate*. Foresight in the field of science and technology makes the future demands for research and education more clear. Foresight studies help us to fuel the knowledge debate and thus contribute towards building a bridge between research and society. The value and use of research become more easily perceived, both by and for the research community, the government, trade and industry and societal organisations. Participation in foresight studies helps each party to better identify itself and feel more responsible for the research in question: each party is a co-owner as it were of the research system. This helps to embed research in society.

This is the Foresight Steering Committee's third and, for the time being, final report. In it, the committee sets out options for the further development of various fields of science. Over the past four years the Foresight Steering Committee has launched a great many foresight processes and has seen the completion of most of them. Investigative background studies were also conducted at the committee's assignment. The results of this work and the Foresight Steering Committee's conclusions are contained in this report. By producing this document, the committee sets out a course for the next steps in the process. I would like to congratulate the Foresight Steering Committee with the way it has performed its assignment.

Foresight reports are working documents; they are not destined for the bookshelf. The Foresight Steering Committee report outlines the research agenda for the next ten to fifteen years. It says, and quite rightly so, that the research organisations in particular must take that agenda and use it to draw up their strategic plans. Parties other than the Foresight Steering Committee will now have to take over: researchers, universities and research organisations such as the Netherlands Organization for Scientific Research, the Royal Netherlands Academy of Arts and Sciences and the Netherlands Organization for Applied Scientific Research, as well as the Dutch Government. On the national level, foresight studies for government must form the basis for working on a knowledge-intensive society. The results of foresight studies can also be of value to the financiers of research (including the departments and ministries) in connection with future investments in research. As the minister responsible for coordinating science policy in the 1997 Science Budget I shall focus on the perspective for fundamental strategic knowledge as outlined by the Foresight Steering Committee. After all, the government is responsible for supporting – by way of research – a sustainable economyyand a vital society in the future.

This report should be regarded as an intermediate stage in a much longer trajectory; a trajectory which the readers of this report will need to shape. As a researcher, a manager or director, or as a user or financier of research, you can now set to work on the basis of this report. Choosing *for* knowledge then becomes choosing *with* knowledge. The yield from foresight studies will ultimately be determined through all the relevant parties making a determined effort to base their further work on this document. I wish you all success in doing so!

The Minister of Education, Culture and Science,

Dr.ir. J.M.M. Ritzen

FOREWORD

A Vital Knowledge System is the Foresight Steering Committee's third report. The *Overlegcommissie Verkenningen* (Foresight Steering Committee) was established by Minister J.M.M. Ritzen in 1992, the minister of Education, Culture and Science.[1] The assignment given to the committee was twofold: (1) to stimulate a widely supported process of foresight studies in the world of scientific research and to put a systematic approach for that purpose to the test; (2) to formulate the options for science and research policy on the basis of foresight study results. Foresight is the process of looking ahead in a changing environment. Foresight, in the world of science and technology, is a means of gaining an insight into the needs for knowledge and the options for research in tomorrow's society. To achieve this, both the researchers and the users of research work together. The objective is to organise our knowledge system in such a way that it will serve our future demand for knowledge.

In its first report[2] the Foresight Steering Committee outlined the approach it planned to take for research foresight in the Netherlands. Based on the initial experiences and reactions, the committee subsequently set out a more detailed explanation of the method it had adopted in its interim report.[3] That report also gave an account of the progress being made on foresight studies in several areas of research. Greater consistency and more order was brought into the multitude of subjects to be subjected to foresight studies, among other things by grouping them under four main areas of knowledge.

The individual foresight activities and studies (all of which have been published separately) form the chief product of the past four years for *A Vital Knowledge System*. Grateful use was made of the experience and insight of many people (on both the supply and the demand side of research) during consultations, preliminary conferences, workshops and strategic conferences. These people were responsible for setting out the opportunities, the options and the obstacles in specific areas of research, on the basis of the views they share of the future. The results of their vision and efforts deserve attention and wide support. Support, not only in terms of thoughts and deeds but also in a material sense, from research institutes, intermediary organisations, those in need of knowledge and last but not least, the Minister of Education, Culture and Science and his colleagues in the Dutch Cabinet.

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[1] What was then known as the Ministry of Education and Science.

[2] *Kompas en kijker* (Compass and Telescope: a framework for foresight activities in the field of science and technology), Foresight Steering Committee, October 1992.

[3] *Koersen op kennis* (Setting course for Knowledge), Foresight Steering Committee, May 1994.

This final report of the Foresight Steering Committee is typical of a sort of 'half-time score', a random picture at a given moment in time. Science and society are constantly on the move and as long as there is a future there is still foresight work to be done. As far as that work is concerned the committee was impressed by the seriousness and the enthusiasm with which the foresight studies discussed in this report were undertaken and conducted. The Foresight Steering Committee's independent role, plus the opportunities it had to stimulate initiatives with its own financial resources, might have contributed towards that.

The foregoing lead us to believe that this process will be continued and indeed be productive. A process in which a vital knowledge system, in intensive interplay with the immediate surroundings of that system, will continue to gear itself towards all the future needs for knowledge.

Dr. A.D. Wolff-Albers
Chair of the Foresight Steering Committee

SUMMARY

What kind of research and which technologies does the Netherlands need with a view to the future? Where, in the international context, do the opportunities for our nation lie? How can these demands for knowledge and long-term research opportunities best be brought into line? These are pivotal questions in science and technology foresight studies. They are also questions which this report will attempt to start to answer on the basis of the results of four years of foresight.

Over the past four years the Foresight Steering Committee has been closely involved with sixteen such foresight studies, as the initiator, as participant or as commentator. A similar number of more minor foresight activities were also executed. Working with scenarios, in which the appropriate societal developments and uncertain factors of relevance for the research were tracked down, turned out to be a very useful tool.

The individual foresight activities revealed a wealth of information and understanding with regard to the (future) supply of and demand for knowledge. The main lines of the foresight study results will be discussed in Section B of this report. These results also formed the basis for the reflections contained in this main part of the report (Section A). The relationship is outlined here between the main insights and conclusions of the foresight process as a whole. When arranging and analysing these relationships the Foresight Steering Committee had two objectives in mind. The first was to strengthen the foundations and boost the vitality of the Dutch knowledge system. The second was the committee's aim to increase that system's sensitivity to any changes in its social environment.

The Foresight Steering Committee's activities had by no means the pretence of covering the whole range of science and technology developments in the Netherlands. The main point was to make in-depth, future-oriented analyses in a relatively limited number of fields, in which the benefit and the underlying questions of a foresight study could be clearly defined. A foresight study using the Foresight Steering Committee method calls for an enormous amount of dedication, creativity and flexibility of all those involved: both the researchers and the users of research. Consequently, all foresight activities were only given the go-ahead if definite signals had been received from the research field in question indicating the need for such a study. Sometimes it was for the purpose of helping resolve strategic dilemmas, and sometimes to gain outside encouragement for the reorientation of long-term developments.

SYMBIOSIS

Skilful research furthers science and is beneficial for society in both the short and the long term. Skilful research is developed in a fruitful symbiosis between science and society. The condition required to achieve such a close relationship is a strong and vital knowledge system which interacts intensively with its surroundings. A knowledge system of adequate quality, which has sufficient continuity for it to produce scientific innovations; a system which is dynamic enough for it to react alertly and to anticipate the changes in our society.

It is also a system in which self-organisation, differentiation and profiling between the different institutions are the points of departure for strategic cooperation. This is not only necessary because of the scaling-up of research and the increasing costs and limited resources. It is certainly equally as important for the higher degree of multidisciplinarity called for in the approach to scientific and societal issues.

These notions are explained in Chapter 1. Also dealt with in Chapter 1 is the demand side of research, the relationship between the augmentation of knowledge and innovation, as well as the various responsibilities of government. The foresight studies show that certain elements of self-organisation and strategic orientation in the knowledge system still need strengthening. This will expand the ability to generate knowledge and reinforce faith in the system's ability to resolve problems. The other side to self-organisation is obviously the obligation to account for and justify how the funds have been spent, as well as to account for and justify the research strategies that have been adopted.

The financial basis is of importance for the vitality of the knowledge system. This basis has been substantially weakened in the Netherlands too (as the Foresight Steering Committee also notes in the final section of Chapter 1). Our research investments have fallen below the European average over the past decade. This contrasts sharply with the increasing costs of research and the growing intensity of knowledge in several sectors of society in the international dimension. If the Netherlands is to realise its ambitions as a 'knowledge nation', it will be essential to achieve an upswing in its investments in research and technology. The Foresight Steering Committee would like to see this level of investment brought back up to 2% of the Gross National Product (GNP) by the year 2000.

KNOWLEDGE THEMES

Chapter 2 points out that there are several dominant developments under way in society which will set new challenges for research. The changes that have been observed are brought to the fore in the analyses of the surroundings in individual foresight studies as well as in future-oriented studies, conducted by other organisations, which were not restricted to the research sector. They have been grouped under four headings, namely:
- information and communication in the knowledge-based society;
- the strife towards a vital and sustainable economy;
- internationalisation, with regionalisation as its counterpart;
- improving the quality of life.

These are the trends that will determine the needs for knowledge in the various sectors of our society and in government. What is the specific nature of these trends? What problems can they cause? What opportunities do they present? It is very important for the vitality of tomorrow's society that we understand and come to grips with the answers to these questions. Scientific research is able to provide that understanding and can contribute towards new technological alternatives.

With this goal in mind the Foresight Steering Committee calls for concentrated research efforts on a number of 'knowledge themes', based on the coherence between foresight results. These themes for future research are summarised in Chapter 2 in the following recommendations:

1 Incorporate a research programme in the National Electronic Highways Action Programme, aiming at innovations in the long term.

2 Organise a long-term, multidisciplinary research effort into learning and human capital in the knowledge-based society.

3 Intensify research for innovations and improvement of quality in the agriculture and food cluster.

4 Stimulate and bring consistency into research for the service sector; research which is becoming increasingly important for the Dutch economy.

5 Start a National Research Initiative 'Factor 4', aiming to reduce the environmental impact by half, even if the nation's prosperity doubles, in which existing institutes participate and bring their strategies into line.

6 Intensify research into the integral utilisation of space and into resolving the acute problem of lack of space in the Netherlands.

7 Encourage research into the development of business activity and innovation processes in support of the restructuring of Dutch industry.

8 Stimulate multidisciplinary research into administrative and socio-cultural internationalisation.

9 Organise a multidisciplinary research effort into social cohesion, with individualisation, new social relations and roles of the government as the main aspects.

10 Effectuate the new priorities in health research, focusing on the 'quality of life' and the efficacy of the health service.

STRATEGY AND ORGANISATION

A better gearing of research towards society's demands for knowledge only makes sense if the research system itself is neat and orderly. Chapter 1 outlines the general basic conditions required to achieve this. However, the main fields of science also set their own specific demands in terms of organisation and strategy. In Chapter 3 the Foresight Steering Committee puts forward several recommendations for consolidating research in engineering and the natural sciences, in the social and behavioural sciences, the humanities and in health research.

Dutch research in *engineering and the natural sciences* is acclaimed internationally. However, there are several urgent questions that play a role here which are institutional by nature and are related to the decreasing number of students, the emergence of innovative, multidisciplinary areas of technology, and to the disappearing line between the engineering and the natural sciences.

11 The Foresight Steering Committee requested the Royal Netherlands Academy of Arts and Sciences to set up a committee for the purpose of mapping out the strategic options for engineering and the natural sciences. It is the intention that this committee will present a plan of approach this year.

The quality of society-steered research in the field of the *social sciences* calls for a more solid fundamental basis. This will be a question of research into the most important developments and steering processes in society for the purpose of augmenting knowledge.

12 The Foresight Steering Committee concludes that new organisational incentives are called for in the form of long-term multidisciplinary programmes in the social sciences. The users of knowledge must be closely involved in the programming, the financing and the evaluation. The themes that will be the first to become eligible for this are 'social cohesion' and 'human capital'.

The *humanities* have been faced with a long process of fragmentation in the Netherlands. Constant economy measures and a shift from research funds to new disciplines with large numbers of students have affected the actual basis of the humanities. In the main part of this report the Foresight Steering Committee brings yet again the conclusions drawn by the Committee on the Future of the Humanities to the attention of the Minister of Education, Culture and Science, reminding him of his responsibilities:

13 Knowledge in the field of the humanities is the property of the nation; a product which is indispensable, yet for which there is still little willingness to pay for it. Government and institutions will need to make an effort here, each from within the compass of their own responsibilities, to reinforce the actual core of the humanities. Coordination of the policies of individual faculties must also be improved.

There are some very well-developed processes for prioritising *Health research* in the Netherlands from the viewpoint of society, and for profiling in terms of scientific quality. The Foresight Steering Committee sees reason and indeed opportunities for new incentives in this field of science too.

14 Within the field of health research the Foresight Steering Committee calls for:

- reinforcement of the scientific basis of the study programmes;
- intensification of the interaction between health researchers, engineering scientists, industry and the government, focusing on the progress of medical technology;
- more resolute coordination of research of significance for labour, health and social security.

THE PROCESS CHARACTERISTIC OF FORESIGHT STUDIES

Foresight studies contribute more than written conclusions and recommendations alone. They are also responsible, or serve as the catalyst for starting up processes. The most obvious provisional results of the foresight process are the individual foresight reports and their synthesis in this core document. Yet reports are simply documents which reflect the situation at a given point in time, while the processes that have been started up, continue. For instance, the process of intensifying dialogue about closing the gap between the needs for knowledge and the research possibilities between researchers, those that commission research and the consumers of research; or, promoting the coordination among research organisations with regard to missions and strategies; and more in general, the intensification of research orientation towards both its surroundings and the future.

The true result of foresight studies is that they lead to action. In other words: if all the parties in the research process allow themselves to be led by the results when making strategic decisions. The findings of the individual foresight studies can be instructive and profitable, particularly for those parties with a direct involvement in specific fields of research. The themes mentioned in Chapter 2 offer points of departure for research organisations, trade and industry, societal organisations and specifically for the government too, especially the coordinating ministers for science and technology policy and their colleague specialist ministers. The recommendations contained in Chapters 1 and 3 for the vitality of the Dutch knowledge system touch upon the responsibilities of the system itself and those of the Minister of Education, Culture and Science.

Section A

A VITAL KNOWLEDGE SYSTEM

1

TOWARDS A NEW SYMBIOSIS OF SCIENCE AND SOCIETY

Making choices both in and for research. That is what this report, the research world itself and science and technology policy is all about. To be more accurate: choosing, jointly, for the development of research with a view to the future for the benefit of society. Now this is easier said than done. The first complication is concealed in the stipulation 'to benefit society'. This is all too easily constricted to application-oriented research or research which serves the economic interest in particular. The second difficult element is the 'future perspective'. However intensive a foresight study might be it will always to a certain extent imply: making an educated guess, leaving sufficient latitude for uncertain elements. In other words: not being too hasty to latch on to facts but simply analysing the changes in the research itself and its surroundings in order to look at the various options.

While it is essential to do it 'jointly', this also entails an extra complication. How are the responsibilities for establishing strategy and policy divided among research institutions, those that commission research and those that use research, societal groups and the government? It is clear that their views on the line of research and how it is organised do not always run parallel, nor do their views about who is responsible for what.

Entwined in all of this is the question of 'talent', top talent in particular. This manifests itself individually, or conversely, in bringing together the most suitable people. Talent cannot be constrained; this applies in two different ways. First of all, there must be an aptitude, and that aptitude must be brought out in the right way. Secondly, it must be possible to develop that talent freely. Only then will it become difficult to force that talent into a 'policy harness'. This is why science policy is a policy that has to create latitude. Creative latitude, within which top talent can be nurtured and allowed to develop. Simultaneously, top talent must be constantly faced with a challenge by placing it in a stimulating environment, by asking interesting questions, an excellent group, the best facilities. Nor may that talent be dispersed over plots which are too small. It is especially in the way we nurture our talent that the opportunities for responsible stimulation are to be found.

Science and society have become progressively closer interwoven over the past few decades in more ways than one. A continually increasing number of people are receiving continually better education. Research has automatically started to become part and parcel of policy. Services based on the utilisation of knowledge become more significant as an economic factor. Knowledge-intensity is also on the increase in other sectors too. In short: society's knowledge needs really have started to determine the research agenda.

This process of growing societal influence is a welcome and often very productive one. Yet it is by no means a process which lacks tension. An excessive demand on research for short-term solutions is a threat to the necessary continuity. On the other hand, parts of our knowledge system show a too low level of receptiveness with regard to the needs in the immediate surroundings. Another factor is that it is difficult for certain parts of society to formulate their knowledge needs clearly. Finally, over the past decade the relative decrease in investments in both public and private research has brought the relations under pressure.

Box 1 The increasing level of societal influence

There was a time, not very long ago, when the relationship between science and society seemed less complicated. The slogan of the World Fair of 1933 in Chicago was "Science explores, Technology executes, Man conforms." Science pointed the way, technology paved the way and man and society changed their ways. Huxley's Brave New World, published in 1932 did not appear out of thin air.

Whereas 60 years ago science virtually set the tone without questions being asked and society had very little to say, it would seem as if the roles have been reversed in today's world. The tax payer of 1996 is less docile and patient. While society follows the science industry critically and questions it assiduously, albeit it sometimes less critical. In its science and technology policy the government searches for a balance between the freedom of research and social responsibility. Researchers pave their way through bureaucratic procedures. Meanwhile, top talent generally goes its own way.

The Foresight Steering Committee notes that certain aspects desperately need a new élan, a reinforcement of the dynamism in the relationships between science and society. A reflection on the societal functions attributed to research is called for if we are to maintain the solidity of our knowledge system. An intensification of the reciprocity between research and its surroundings is required to allow us to utilise our knowledge potential better.

It was against this background that the Foresight Steering Committee was given the task of contributing towards bringing the future demand for and the supply of knowledge more into line. This, says the committee, must be given shape in a renewed, flowing and dynamic symbiosis between science and society.

Work is under way on such a new relationship; this is also evident from the foresight studies. Nevertheless, more steps are needed to develop it further.

1.1 Interaction between research and its surroundings

The first step is to intensify the interaction between the research system itself and its surroundings. According to the traditional model, reciprocity is achieved along two routes: one from research, the other from society. Research on the first route mainly takes the pathway of scientific interest. This generally leads to productive results which are difficult to predict. The second route entails research being steered effectively from within society. Societal issues and the need for innovations activate the development of new knowledge. In practice, however, neither the augmentation of knowledge nor innovation follow a simple linear route. Both are cyclic processes, each having their own characteristic dynamism, each propelling the other in complex interaction (see box 2). It is especially the links between the two processes - and the addition of links where they are lacking - that are important to achieve a sound coordination between research options and the needs for knowledge. It is here where points of action are to be found for a new symbiosis between science and society.

An introvert research system which focuses mainly on the augmentation of knowledge, in which there is a lack of interest in societal issues and the needs for innovation, will in due course reach a deadlock. External stimuli are ignored; research loses its innovative and critical powers. This is not only disastrous for societal innovations but also undermines the legitimacy of the research system and the willingness to invest in it.

If research wishes to hold on to the support it has in society, this will only be possible if it maintains intense contact with its surroundings. Interaction occurs in a variety of ways: through education, contract research, professors occupying endowed chairs, exchange programmes and the secondment of researchers, joint research programmes and projects, supervisory committees, etc. Foresight studies are also a means of encouraging this interaction. Another is to give the societal significance of research a distinct place in research assessment.

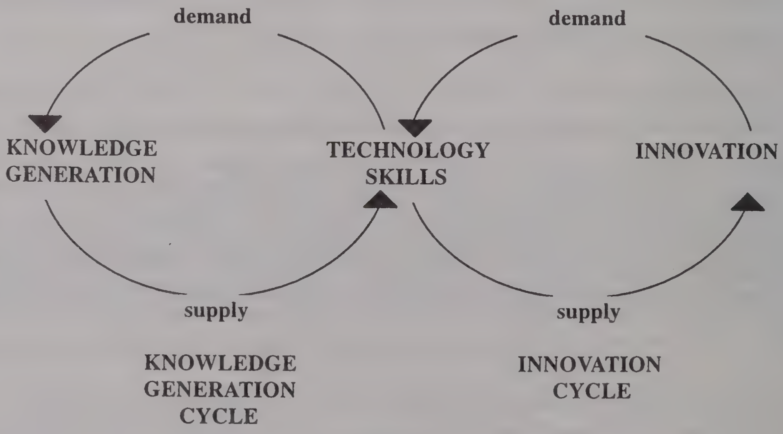
Box 2 From Linear model to cyclic process

The traditional view of coordination between science and society is a simple one. Fundamental research, conducted by autonomous researchers, is the source of innovation. Investments in research are investments for prosperity and well-being in the long term. Exactly what the yield from research, i.e. from the investment will be, is obscure. Yet in the long term the yield will certainly be a fruitful one in this linear science push model through applied research and development. The organisation and financing of scientific research has for many years been based on this view.

However, another view took over in the science policy of the nineteen-eighties. It is not scientific research that is always at the forefront of society's progress; other driving forces are societal challenges and innovative ideas. Resolving problems and realising innovations calls for knowledge. If fundamental research is required to achieve this then researchers will need to produce that knowledge in accordance with this demand driven model.

The two models are attractive in their simplicity. But, as usual, the practical situation is less compliant. Scientific, technological and societal developments are seldom in line with simple causal patterns. The suggested simplicity is therefore misleading. Linear models leave little room for the internal dynamism of knowledge generation and innovation. Nor do they do justice to the complex reciprocity of those two processes, a reciprocity which is so characteristic of the interaction between research and its surroundings.

The following diagram stresses the interlock between the knowledge generation and innovation cycles:



THE DEMAND SIDE

Improving the reciprocity between science and society is obviously not a task for the research community alone. The users of knowledge and the government must also make their contribution. On the demand side, for instance, it would seem that the existing options for the stimulation of research (fiscal facilities for example) are still used insufficiently. Also, it often appears difficult to formulate the (future) needs for knowledge either clearly or in good time. One well-known problem in this respect is the difference in time horizon. The 'market dynamics' do not make it any easier for trade and industry and other segments of society to look ahead for any period longer than three to five years. Conversely, the 'gestation period' for innovative research is in the range of eight to fifteen years. This tension tends to play tricks on the small and medium-sized business sector in particular. It is impossible to eradicate it; the only thing to do is to handle it well. On the one hand, it makes it quite clear that research should not focus on short-term issues alone. On the other, it implies that the demand side must search for ways to bring the more distant needs for knowledge into view. Foresight studies, in which researchers and users of knowledge join forces and look at future developments together, can be of help here. Trade and industrial organisations can act as the intermediaries for those operating in the small and medium-sized business sector.

Also in a policy sense does the strife towards a new symbiosis demand reflection on the actual functions of our knowledge system. The political world and trade and industry must become more aware that the innovation cycle will only be able to thrive if the cycles of knowledge augmentation and increasing understanding also flourish. The science and technology policy as formulated in *Kennis in beweging*[1] and adopted in the Netherlands in recent years does tend to boost the innovation cycle. However, it still devotes too little attention to the complementary cycle of knowledge generation and thus runs the risk that the innovation process will also stagnate in due course since the flywheel will tend to loose momentum.

A change of course is also required on another aspect. More convincing than ever before will science and technology policy need to express that 'The Netherlands, Land of Knowledge' covers more than a strictly economic context. Our knowledge potential for the 21st Century must also focus on cultural vitality, social resilience, ecological merit and administrative-political flexibility. All of which are essential qualities for a vital society. At the same time, these are also qualities which reinforce our economic efficiency and international position.

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[1] *Kennis in beweging* (Knowledge in motion).

THE INTERNATIONAL DIMENSION

Part of the environment of Dutch research is formed by international science. The Dutch share in the world-wide research effort is in the region of 2%. Both the producers and the users of knowledge have started to operate more and more on an international market. In the wake of European unification we also see mechanisms in place between the countries involved to coordinate the research efforts. Nevertheless, this broader context does not lessen the significance of a national foresight process; a process which is necessary to be able to translate the international developments into strategies at national level. Among other aspects, this concerns the training and education of the right kind of researcher who is capable of absorbing important societal trends that take place elsewhere. It also makes it possible for us to dedicate ourselves, in our research, to those areas in which the Netherlands excels or in which the Netherlands has special interests and opportunities. The choice to strive for a European pivotal function in certain areas implies investments to be able to achieve the required quality and scale.

Strategies based on foresight activities in the international perspective also help prepare the Dutch knowledge infrastructure for changes in the demand for research from smaller and large enterprises and organisations. In other words, although the surroundings might be international the foresight studies primarily serve the Dutch interests.

1.2 Self-organisation as the point of departure

A new symbiosis calls for a good balance between dynamism and continuity in the knowledge system. The Foresight Steering Committee has no illusions that the organisation thereof could be steered centrally. Complex and radically changing relationships will arise from the intensive interaction between the knowledge system and its surroundings.

Firstly, this will be the case because the surroundings (the government, industry, societal organisations, etc.) have a constant need for different knowledge partners when designing strategies and when searching for the answers to current societal issues. A second complication is that in most cases the needs of the surroundings cannot be met by research groups organised in one discipline only. The knowledge system must therefore be sufficiently flexible to quickly organise multidisciplinary research and to execute that research efficiently. This calls for more than simply the bringing together of researchers from different disciplines. After all, an increasing number of strategic and existing needs will first of all require the training of researchers who have the right views and best approach. For this reason the universities will need to (continue to) organise the cohesion between education and research (in which their *raison d'être* lies) optimally. Finally, there is also a certain level of complexity due to the fact that the knowledge augmentation cycle and the innovation cycle each has its own dynamism. How these processes will develop, both individually and together, is difficult to predict.

This also brings the boundaries of dynamism into the picture. The knowledge system also assumes continuity. The impatience of the demanding surroundings comes into conflict with indefatigable perseverance and endurance, elements which are essential if existing knowledge is to be augmented. It is therefore especially the government which, by virtue of its science policy, should ensure the continuity of fundamental research in particular. It is that research which provides the basis for successful interplay between knowledge augmentation and innovation and for deepening and reinforcing multidisciplinary questions and solutions. It guarantees that the source of application-oriented inventiveness will not dry up. The Foresight Steering Committee is concerned that this insight into the importance of fundamental research is no longer obvious and therefore calls for the different roles of government to be clearly set out in the science policy.

THE ROLE OF GOVERNMENT

The relationship between the government and research is a multiform one. On the one hand the government sets out the framework for the knowledge system, on the other it participates in that system in different ways itself. As *the body responsible for the publicly-funded part of research* the government finds itself in a difficult situation. It is responsible for creating the conditions and incentives to maintain and strengthen a vital knowledge system for a knowledge-intensive society. It is in connection with this role that we address the government in various parts of this report. Nevertheless, the government must simultaneously adopt a reserved attitude with regard to its involvement with the research system and have faith in that system's ability to regulate itself.

The central steering of education and research in a direction in which the government has an interest in connection with its other roles, will in due course be counter-productive. It will lead to imbalances in the knowledge system and hence to inflexibility in the dynamic interaction between the system and its surroundings. The continuing internationalisation in the field of science is contradictory to forceful top-down steering. Direct interaction between the suppliers and the users of research is becoming more and more evident on the international market. Consequently, this makes coordination by national governments hardly effective, if not impossible.

As *the body responsible for national strategic policy* the government is able to stimulate vital interaction between the knowledge system and its surroundings in two ways. Firstly by critically following that interaction and by producing foresight studies where interaction falters or produces inadequate results. Secondly, by making (financial) incentives available in those areas where the knowledge system needs support to enable it to anticipate changing circumstances in good time, or where societal needs cannot manifest themselves sufficiently (yet) in paid assignments.

The government's third role is that of *principal and consumer of the knowledge system*. The government calls upon research to help provide insight into the societal issues for which it holds the political responsibility. As such, its position is no different from that of other knowledge users. However, in practice, it is confronted far more than the other users with long-term and comprehensive issues. Tackling these issues may not be impeded by division and fragmentation of research. Specialist departments consequently need to search for ways of jointly contributing towards the proper functioning of the innovation cycle as well as the cycle of knowledge generation. For the same reason, the government must organise its role as a user of knowledge in such a way that the efforts required to tackle the existing societal issues fit in with its long-term strategies. Only then can the knowledge system serve and support government policy adequately.

Box 3 Multidisciplinarity

Scientific innovation and technical and societal innovations often call for an integrated effort from various disciplines in research. This is made difficult because of the strict disciplinary demarcation made in faculties and most scientific journals, as well as the disciplinary segregation made by the funding organisations. This element has been considered problematic in many foresight studies.

Multidisciplinarity can, and indeed must be promoted through programmes in which the bringing together of different disciplines in a scientific or societal sense gives added value. The organisation, the execution and the management of such research sets special requirements. The greatest challenge is to be found where boundaries between contrasting disciplines are crossed, e.g. between engineering and the social sciences where cultural differences also need to be bridged and expectations regarding each other's possibilities sometimes need adjusting. Maybe the main task for multidisciplinary research is to formulate the problem in such a way that it gives rise to cohesive, complementary research sub-projects, the synthesis of which produces more than simply the sum of the parts. This must take place at the executive level and consequently demands researchers' support. It is for this reason that even in the initial phase of - monodisciplinary - study programmes students must develop a sense of necessity to look further than the boundaries of their own discipline. Only in the second phase* do researchers, on the basis of sound disciplinary instruction, become proficient in working in a multidisciplinary team. It is in these teams that the problems are marked out, defined in their entirety, and the constituent disciplinary questions analysed in such a way that new societal or scientific relevant knowledge emerges from that research. Research schools** have a task here, possibly post-academic education too. Multidisciplinarity can also be given shape in longer programmes worked on collectively by university research groups, organisations for applied research and trade and industry.

Multidisciplinary research should be given the opportunity to mature. While it is as yet unable to measure up to monodisciplinary research on all counts in terms of quality, and scientific relevance, it's societal significance will need to carry more weight in the assessment of research proposals. Insight into those practices that contribute towards the success of multidisciplinary research will need to be expanded and disseminated.

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* In 1982 university education acquired a two-tier structure. In the first phase, scheduled to last four years, students receive an academic foundation course in their chosen subject. The second phase affords the opportunity for specialisation, for example in the form of a graduate programme leading to PhD research, or a university programme of teacher training.

** The present structure of scientific research in the Netherlands is also undergoing change. From the beginning of the nineties, the universities have been occupied in setting up research schools. These research schools – cooperative associations of the research groups and faculties, mostly of different universities – have two tasks: bringing together the best research in the Netherlands and providing education and training for the AIOs and OIOs.

1.3 Self-organisation and accountability

The Foresight Steering Committee therefore calls for a government which adopts a reserved attitude towards the knowledge system and has faith in the ability of that system to organise itself. This may not be misunderstood as a plea for unlimited autonomy. Scientific research can only meet international standards if it is required to comply with the rules that the scientific world itself establishes in terms of quality and scientific significance. In that sense science must rely on itself. Naturally, it also contacts the users with regard to the societal significance.

As a unique cultural and political instrument Dutch research has long been embedded in a system of checks and balances of intermediary organisations; a system which compels cooperation and coordination. The material collected by the Foresight Steering Committee clearly shows that this system of self-organisation – typical in the Dutch context – tends rather to encourage than hinder a strong international position of our research. Nevertheless, it is also evident that this system is not strongly developed in all fields of research. The necessary strategic orientation and the forming of alliances will need to be shaped more effectively in certain areas. One example of an extremely vital organisation is medicine; the structure is weaker in the social sciences and in some of the humanities. The research schools emerging rapidly, also in the latter disciplines, can improve this weakness and the resulting deficient symbiosis between these parts of the knowledge system and the social environment. However, one condition needed to achieve this (as was pointed out earlier) is that the close connection between education and research continues to be productive.

The existing division of tasks among the intermediary organisations is also inadequately suited to the growing need for multidisciplinary research. Again, the Foresight Steering Committee notes that both the furtherance of science itself as well as the changing relationship between society and science, tends to make this need greater. The indispensable foundations of such research are to be found in well-organised mono-disciplinary research and education, two elements for which the universities are primarily responsible. They are consequently required to acquaint students with the possibilities and perspectives of a multidisciplinary approach in the initial phase of their study programme. In the second phase the programmes will need to focus more specifically on making new researchers proficient in this kind of scientific work. Research schools are able to play a significant role in this respect. If they are not given sufficient stimuli from their social environment for their research and education programming, they will need to have the support of intermediary bodies such as sectoral councils and the Netherlands Organisation for Scientific Research.

Box 4 The missions of research institutes

Totally or predominantly publicly-funded research in the Netherlands is conducted in various institutions, all with varying missions. A dynamic knowledge system requires that these differences be highlighted.

The main task of the *universities* is to conduct fundamental, scientific research in particular and to provide the academic education connected with that research. As a derivative of this main task they perform research and teach on a contract basis and also provide services to society.

The research institutes of the NWO (Netherlands Organization for Scientific Research) and KNAW (Royal Netherlands Academy of Arts and Sciences) function complementary to the main tasks of the universities. These institutes conduct research in specialised areas for which the universities have no, or only limited facilities, or research which by virtue of its nature is less appropriate in a university setting. The knowledge developed in these institutes is frequently introduced in postgraduate courses, e.g. via participation in research schools.

TNO (Netherlands Organization for Applied Scientific Research) and the principal technological institutes primarily meet the demand for 'purchased' applied research from central and local governments and from businesses and organisations. This also applies with regard to a number of research institutes in the field of the social sciences which have united in the VOI (Association of Research Institutes) and for those institutes united in the DLO (Agricultural Research Service).

Departmental research institutes conduct research of relevance to policy. A separate organisational structure and a direct link with the principal is required here for the sake of decisiveness in and continuity of government policy.

The relative autonomy of the knowledge system (essential for its vitality) is inextricably linked with the accountability commitment. It is quite rightly expected of research institutions that they account for and justify their spending of funds made available from society, not only in a monetary sense but also in terms of content. Internal organisation problems and external legislation and regulations may not be allowed to stand in the way of fulfilling this requirement, as is often the case at present.

The scaling-up of research, the necessity of multidisciplinary methods and limited resources necessitate both collaboration and differentiation among research institutions. Research institutes must stress their distinctive features with regard to both these elements in their strategic plans, for which they bear responsibility for the results. Differentiation and profiling in recognisable missions and unambiguous strategies are beneficial for choosing the most appropriate alliances. Moreover, this makes the whole range of research options more understandable for those in need of knowledge.

The myth of equality and the subsequent uniform treatment of universities must be shattered given that it elicits false competition and impedes coordination and subject specialisation. To benefit the vitality of the knowledge system and symbiosis with its surroundings the universities must be identifiable as 'public utility companies', each with its own strong and weak points. The current open, public nature of the system of quality control for research in the Netherlands, implemented by the universities themselves and developed within the framework of the Association of Universities in the Netherlands, serves to promote differentiation and profiling. Taking these pathways can lead to a new balance of self-organisation and accountability, making possible a productive symbiosis between the knowledge system and its social environment.

1.4 Financing

A vital knowledge system which is profitable for society cannot be procured at discount prices. In the Netherlands a total of Dfl. 10.6 billion was spent in 1993 on research and technology development. That was 1.9% of the Gross National Product (GNP). Trade and industry (5.8 billion) and the government (4.8 billion) were the main financiers. The monetary value of the skills and the scientific and societal quality that is embedded in Dutch research can hardly be overestimated. Considering our nation's ambitions regarding knowledge the main thing is to keep that value up to standard. After all, investments in knowledge are investments in societal innovation, in prosperity, employment and in competitive strength. Such expenditure also has a multiplier effect; it generates other investments: in production capacity, in services and in infrastructural facilities.

The European average expenditure on research and technology is currently in the region of 2% of GNP. We see figures above the 2% mark in countries which have managed to maintain vitality in their knowledge system and have geared it up to the needs of the 21st Century. Figures below 2% are seen in those countries engaged in disinvestment or where the knowledge system is still in the initial stages. The level of expenditure on R&D in the European Union is clearly behind that of nations like Japan and the USA where it is in the region of 3% of GNP. Hence the recommendation made in the *Delors White Paper* from a few years back to gradually bring up investments in knowledge in the EU to 3%. With this in mind it is all the more alarming to see that since 1987 Dutch research expenditure has fallen below the European average, while before that date it had always been above it. The downswing in trade and industry's expenditure on research and technology was the main cause.

The problem is that the consequences of economising on long-term investments in research only become perceptible in the long term. Moreover, with future challenges in mind several aspects of the current knowledge infrastructure need reinforcing; this is also indicated in foresight studies. According to the Foresight Steering Committee, maintaining the standard of, and indeed increasing our knowledge potential cannot be achieved without also increasing the level of investments. The committee sees the following reasons for this.

The growing knowledge intensity in many sectors of society increases the need for good research training. The cost of research, in terms of instruments, programming and manpower, are on the increase in the international dimension. As indicated in the foregoing, Dutch research expenditure has decreased despite the fact that society's needs for research, as shown in the foresight studies, call for extra financial incentives.

Without attaching any conditions it is difficult to set 2% GNP as the absolute criterion for the financial basis that supports our knowledge system. There are substantial differences to be seen among the different nations in the structure and orientation of their knowledge infrastructures. Moreover, the total volume is not the only reason to rejoice; on what the resources are spent, and how efficiently they are spent is also important. Nevertheless, the percentage of GNP could be used as a significant signal.

It must be pointed out that government investments in research in the Netherlands dropped from 1% in 1987 to 0.8% of GNP today. R&D expenditure in private enterprise fell even more: from 1.3% to 0.9%. It is difficult to avoid the impression that trade and industry is showing a tendency to pass off relevant research onto the public sector. A recent CBS (Netherlands Bureau of Statistics) and CPB (Netherlands Central Planning Office) study[2] shows that these decreases are not compensated by other immaterial investments, such as education, licences, etc.

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[2] *Immateriële investeringen in Nederland* (Immaterial investments in the Netherlands), CBS/CPB, 1995.

This trend is very much in conflict with the repeatedly acknowledged importance of investing in knowledge. If that importance is taken seriously then substantial efforts are called for, in both the public and the private sector, to bring the investments into line with the ambitions.

> **The Foresight Steering Committee urgently recommends that the government makes its contribution in order that the research expenditure can once again be brought up to an adequate level by the year 2000; 2% of GNP could serve as the target figure.**

Such an effort is essential given that (as also shown in the foresight results) there is reason for new, powerful incentives for research in many areas. The following chapters show which societal and scientific tasks our knowledge system will have to face with a view to the future. A vital knowledge system must have at its disposal sufficient free resources for it to be able to act in an anticipatory manner.

Chapter 2 outlines several important research themes which emerge from changes in the social environment, all of which demand priority for powerful incentives. A 'mixed' funding method should be considered for the purpose of effectuating that research: specialist departments, local government, trade and industry, other private and semi-public organisations and research institutes. The Netherlands Organization for Scientific Research could (in line with the ambitions expressed in its strategy document[3]) take the lead in defining and developing such programmes. The role of stimulator is set aside for the ministers responsible for coordinating science and technology policy.
Chapter 3 puts forward several urgent questions which are of importance for drawing up sound strategy in the four main fields of science. The Minister of Education, Culture and Science is responsible for this in view of his concern for the vitality of the Dutch research system.

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[3] *Kennis verrijkt* (Knowledge enlightens).

2

RESEARCH FOR SOCIETY

A vital knowledge system is a system which focuses on the developments that occur in its surroundings. Foresight studies are an important tool in this respect. Using the results of foresight studies it becomes possible to bring the supply and demand of research into line on the basis of a vision of the future trends.

Four *main lines* that will be decisive for the future demand for expertise in the Netherlands were reported in analyses of the surroundings carried out in the individual science and technology foresight studies, and also in foresight studies conducted outside the research sector (Netherlands Central Planning Office, Socio-cultural Planning Department, Advisory Council on Government Policy, international studies):

- information and communication in a knowledge-based society;
- the aim towards a vital and sustainable economy;
- internationalisation and regionalisation;
- improving the quality of life.

All four lines are interrelated. The information revolution influences internationalisation; internationalisation and regionalisation are extremely important for our country's economy; without a strong, clean economy it will be difficult to fulfil our ambitions regarding the quality of life.

Developments in society within these four main lines require research to be carried out in all disciplines. Research that provides an insight into their nature and their effects. Research to find solutions to the interrelated problems. Also research to utilise the opportunities connected with those developments for technical and societal innovations. This chapter sheds light on the consequences of the four main lines and sets out ten recommendations for bringing research into line with society's future knowledge needs.

2.1 Information and communication in the knowledge-based society

The explosive growth in the number of options for using information and for communication ensuing from information technology continues unrelentingly. This has an enormous effect on society and evokes many new requests for research. The availability and low-threshold accessibility of high-tech communication and information systems is a crucial factor for the progress of our prosperity and welfare. In this context the government assumes a coordinating and stimulating role.

Knowledge intensity is increasing in virtually all sectors of our society. Knowledge and human capital determine the differences in growth among the different nations. The percentage of the labour force with an academic education will increase, and thus the opportunities for the government, industry and society to contribute towards the furtherance of knowledge will also increase.

New networks will arise in which knowledge will be produced, disseminated and managed. Typical is the growing interweave of the further development of scientific knowledge and related expertise and practices in society. Accessing knowledge and technology, keeping up knowledge augmentation, and navigating through the knowledge arsenal, are all significant issues for nations, organisations and for the individual as well. Learning to learn, and continuing to learn, will become prerequisite.

Information technology also presents scientific research with new possibilities, among other things through the greater computing power, more efficient search options for existing research results, through the linkage and analysis of data bases and through faster and more efficient interaction with colleagues, with the industry and with societal groups.

DEVELOPING THE INFORMATION AND COMMUNICATION STRUCTURE

By introducing the current National Electronic Highways Action Programme the government promoted the realisation of an advanced and widely accessible information and communication infrastructure in the Netherlands. Such an infrastructure is essential for developing new services and applications. This will enable the Netherlands to hold on to its strong position as a producer and exporter of knowledge and services. The plans that have been developed must lead to private enterprise investing in the relatively short term in such basic facilities as broadband frequencies and peripheral equipment for channel access and investments in services via those channels. Nevertheless, current information and communication technology is still relatively primitive when compared with the visionary applications described by many. Nor is a great deal known about the non-technological aspects of introducing electronic highways. Research in these areas is desperately needed in the long term.

Incorporate a research programme in the National Electronic Highways Action Programme, aiming at innovations in the long term.

Potential elements for such a research programme that came to the fore in the foresight studies and preliminary studies were:

- The development of expert systems and autonomous cognitive systems based on the concept of human cognition and the interaction between man and machine. Significant fields of study are computer science, linguistics, language technology and the cognitive sciences. A foresight study in the field of computer science will soon be completed; a foresight study for the cognitive sciences has already been started. The Netherlands Organization for Scientific Research has set up a Language Technology Priority Programme focusing on the development of a travel information system. This can serve as a model for the structure of other specific capital-intensive investments in advanced information and communication technology applications, for example in the financial sector, education and in legal practice. *(Modern Languages Foresight Study; Cognitive Sciences Foresight Study; Information and Communication Technology Foresight Study; Computer Science Foresight Study)*
- The development of effective and efficient facilities for the storage, processing, recognition and the display of (moving) images, sound and text and data. Future technologies will be based on microsystem technology and nanotechnology. Fields of research here are optoelectronics, photonics, display unit technologies, data compression methods, modelling and representation software (including three-dimensional) and production technology for microsystems and nanostructures. *(Information and Communication Technology Preliminary Study, Nanotechnology Study, Microsystem Technology Study)*

HUMAN CAPITAL

Progress in information and communication technology is a major incentive for the knowledge-based society. New options for individual tutoring, distance learning, innovative teaching methods and for 'lifelong learning' are on their way. Knowledge intensification in connection with industrial, administrative and societal activities continually set more stringent demands on individuals; this can be seen in the increasing number of industrial training schemes. Foresight studies into educational research and into research in the field of human capital show that while their potential impact is substantial, relatively little is known about the possibilities and effects of these developments on education.

Organise a long-term, multidisciplinary research effort into learning and human capital in the knowledge-based society.

The foresight studies suggest the following research themes to achieve this:

- Multidisciplinary research into the relations between the teaching process, the institutional structure of education and the return on investment in human capital. At present this is done through educational studies and economics. Collecting longitudinal data on level of education, income trends, work experience and educational returns is essential for the development of this research. *(Preliminary Study into Human Capital, Working Group on Strategy for the Social Sciences)*
- Research for the implementation of information and communication technology in teaching. A total concept must be developed which offers insight into the relationships between education, communication and informatisation, in the relationship between school education and non-school-linked education, and in the relationship between formal and informal teaching. *(Educational Research Foresight, Preliminary Study into the Cognitive Sciences)*
- Scientific and policy-oriented research into all existing and essential forms of vocationally oriented education for adults, their effectiveness and efficiency and their individual and societal returns. *(Educational Research Foresight)*

2.2 Towards a vital and sustainable economy

Economic activity changes as a result of the increasing level of international competition, a more stringent environmental and energy policy and information technology. Employment in industry is on the decrease. More employment is available in the service sector. Medium-sized and sometimes small enterprises internationalise in order to make the best use of their market opportunities (see box 5).

There is intense societal and economic pressure to make products and production processes sustainable. Latitude for this is created through informatisation, miniaturising and dematerialising industrial activity (more efficient use of raw materials; from bulk to high tech). For the processing industry this means a radical shift to products which have a high added value.

Box 5 Research for Dutch Industry

Dutch industry has a particularly strong position in the processing industry (e.g. basic chemicals, oil refining, base metal, paper and beverages) and in the more traditional sector (food industry, printing trade, electrical apparatus, glass, agricultural machinery and the textiles industry for instance). High-tech industry in the Netherlands is not quite as advanced, and sectors like the motorcar industry, the aircraft industry, pharmacy, electronics, coatings and special machinery, is dominated by a few enterprises only.

Strong industrial clusters are the agro-industrial complex and the goods and services products located near the port of Rotterdam and Schiphol Airport. The high quality of services, the high quality of the fundamental research and the stable socioeconomic climate are major competititive advantages here.

A study published by the Netherlands Central Planning Office,[1] shows that internationalisation and a more stringent environmental and energy policy has put the Netherlands under pressure. Low-level activities will be transferred to emerging industrial countries (including countries in Eastern Europe). To follow the industrial developments in Europe we need more than proportional restructuring. The traditional sector will need to (continue to) focus on the development of high-quality niches in the market by making use of high-tech products, by improving quality (sustainability, flexibility, delivery time, production to customer specifications) and by increasing the design and development capacity. The processing industry will need to move on to high-grade segments by making use of biotechnology, new materials and so-called generic technologies such as microsystem technology, nanotechnology and optoelectronics. This implies that the high-tech industry will have to be reinforced.

The general strategy we are able to extrapolate from Central Planning Office studies is a shift in industry to more advanced segments of the market and to high-tech products. This will require an increase in the R&D effort as well as an increase in our knowledge of technology, the market and languages.

The recommendations made in this report are in line with this strategy. We call for research for the agro-industrial complex and the service sector, for research into the integral utilisation of space and development of the information and communication infrastructure to maintain and expand the existing efficient clusters. The National Research Initiative 'Factor 4' focuses on supporting the restructuring of the processing industry. A reorientation and profiling of engineering and the natural sciences will be required to realise the shift towards more advanced segments of the market; existing strong points of fundamental research will need to be used in this context. Research into 'human capital', 'business activity and innovation' and into 'international and regional processes of change' is essential to strengthen the strategic capacity of businesses, the government and society.

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[1] *Nederland in drievoud* (The Netherlands in triplicate).

There is a clearly perceptible trend towards a network economy. Innovations are now being developed together with potential suppliers. Small businesses will need to increase their design and development capacity. Being able to handle mutual dependencies is a determinative factor for success.

Viable economic activities are progressively being characterised by their high added value. Knowledge, embodied in highly-trained employees and in capital goods or in R&D, is also becoming increasingly important.

The foresight studies confirm the picture drawn in previous studies showing options for new high-tech activity on the basis of existing technological research capacity. *Biotechnology*, for example, a field in which the Netherlands has built up an enormous potency of relevance for agriculture, the chemical and food industries. The Netherlands also has strong centres in *microsystem technology*. The world market for silicon micro-engineering-based products will increase by 20% a year. This is a most attractive basis for entrepreneurs. Collaboration among existing businesses and designer training courses at universities and financial support for new entrepreneurs are important elements in this respect. The Netherlands also offers good opportunities for a *medico-technological cluster*: excellent academic faculties and hospitals on the one hand, and pharmaceutical businesses and businesses operating in the field of specialised technology on the other. Specifically, there are ample opportunities emerging for imaging and image processing technology. *Environmentally-inspired process technology* has also reached a high level of development offering the opportunity to develop a strong position in niches in the world market if government, consulting engineers and engineering companies are able to coordinate their strategies. *Energy technology* also offers opportunities. Profiling the Netherlands as a 'gas country' which is striving to become Europe's most efficient gas economy, offers a most suitable strategic framework in this respect. *(The Netherlands Knowledge Portfolio, Technology Map, Energy Research Foresight)*

THE AGRICULTURAL SECTOR AND THE FOOD INDUSTRY

Porter analyses of the Dutch economy,[2] the scenario studies conducted by the Central Planning Office and the Chemistry Foresight Committee show that the agricultural and food cluster is the broadest and deepest cluster in the Netherlands. Broad, given that it comprises many different sectors which act as suppliers for each other and which, together, produce a wide range of end

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[2] *Concurrentiekracht en Innovatief Systeem*, (Competitive Strength and Innovative System) D. Jacobs, P. Boekholt, W. Zegveld, TNO-STB, 1990.

products. Deep, given that each chain involves competitive firms: raw material manufacturers, the food and drugs industry, suppliers, machine builders and service providers. Agriculture is one of the mainstays of the entire cluster. Current trends in agriculture necessitate a reorientation of agricultural research. The other mainstay is the food industry, an industry which is interwoven with agricultural activities and which benefits from the Port of Rotterdam. Environmental policy and internationalisation calls for a strategy that aims to increase quality and develop high-level market segments.

Intensify research for innovations and improve quality in the agriculture and food cluster.

Included in the themes for research suggested in foresight studies were:
- Process technological research for the food industry, aiming to cut down on raw materials and reduce energy consumption, to reuse raw materials and to increase the added value. *(Chemistry Foresight Study)*
- Research into the quality of agricultural produce and food products from the chain perspective. The aim is to measure the quality parameters in integral quality control systems (IQCs) throughout the entire process from production to sales. To achieve this we must be knowledgeable of: how quality is perceived, the transfer of quality characteristics, critical parameters and the measurability of quality characteristics; the genetic and physiological characteristics of animals and plants as factors for essential quality components of food products that make it possible to steer or adjust the production process; the effects of refining agricultural products on health. *(Chemistry Foresight Study, Netherlands Council for Agricultural Research Long-term Perspective)*
- Research into the development of unit operations in processing technology, storage technology and distribution technology. Innovation in this context calls for collaboration among the manufacturers and the users of apparatus, those with product knowledge and specialists in the field of logistics and automation. *(Netherlands Council for Agricultural Research Long-term Perspective)*

THE SERVICE SECTOR

The service sector has gradually developed into the largest sector of the Dutch economy and now holds an almost 70% share of the total employment figure. In contrast with this significant interest, very little attention has been given to research focusing on the service sector to date. This applies with regard to research themes which are significant for the service sector and for the building up of a knowledge infrastructure for this industry.

Stimulate and bring consistency in research for the service sector; a sector which is becoming increasingly important for the Dutch economy.

The term 'service' covers such activities as transport and commercial services, information and communication services, financial services, professional services, recreational, cultural and public services like health care and education. Considering the breadth and diversity of this sector it is impossible to simply establish *the* research priorities of *the* service sector.

Many services are based on the structuring, the utilisation and the transfer of knowledge and information. The easy transfer of knowledge depends on software as the 'knowledge packaging'. Relevant research themes here are:

- Software engineering; knowledge management; data and knowledge systems, including expert systems; the interaction between man and machine; image and sensor processing; robotics, embedded systems, speech recognition and speech synthesis, computer graphics, user-interface systems. *(Preliminary Study into the Cognitive Sciences, Computer Science Foresight Study, Preliminary Study into Knowledge for the Service Sector)*
- Research in the field of mathematical statistics, the theory of probabilities and (mathematic) decision theory. Innovative research in these areas for industry and services is difficult to get started. Consideration should be given to establishing a (European) institute. *(Mathematics Foresight Study)*

Service in the field of finance is one of the knowledge intensive cores of the service sector. Continual technical changes lead to the more-or-less total automation of banking and insurance processes. The rise of information and communication technologies makes it possible to introduce new financial services.

- Research is called for into the development of information technologies, protection technology, data communication, neural networks and the application of new financial services. *(Dutch Knowledge Portfolio Study, Preliminary Study into Knowledge for the Service Sector)*

Research themes which came to the fore in foresight studies for the transport and commercial services are:

- Long-term research into collective passenger transport, into logistic chains, and into the development of intermodal transport. Stimulation of this research is an essential part of reinforcing the knowledge infrastructure in the field of transport and the infrastructure. *(Steering Committee on Traffic, Transport and Infrastructure)*

Here too is high level of interaction with the demand side prerequisite if investments in knowledge are to be profitable. New foresight studies focusing on the needs for knowledge of the different service sectors can contribute towards this. *(Dutch Knowledge Portfolio Study, Preliminary Study into Knowledge for the Service Sector)*

NATIONAL RESEARCH INITIATIVE 'FACTOR 4'

An ecological restructuring of production and consumption will in due course be essential if we are to meet the needs of future generations. Businesses, institutions and citizens alike will have to 'start doing more with less'. In the medium term this relates to doubling the nation's wealth and simultaneously cutting the consumption of raw materials by half, as well as reducing the environmental load by half ('factor 4'). To achieve this there are many technical and organisational possibilities which need developing further. Collaboration is called for in this respect from the natural sciences, engineering sciences and the social and behavioural sciences.

> **Start a National Research Initiative 'Factor 4', aiming to reduce the environmental impact by half, even if the nation's prosperity doubles, in which existing institutes participate and bring their strategies into line.**

The foresight studies suggested the following elements for such an initiative:

- A concentration of energy research into reducing the cost price of renewable sources of energy and into raising the level of energy efficiency by utilising gas technologies in households and businesses. Expanding the current research effort and improving the structure for the required programming is important. Novem and the Netherlands Organization for Scientific Research could play a main role here. *(Energy Research Foresight Study)*
- The application of microsystem technology for the development of production technology and industrial process control and for the agricultural and medical sector for instance. Waste streams could be minimised by taking continuous measurements and by adopting more accurate production techniques. *(Microsystem Technology Study)*
- Process technological, catalytic and biotechnological research focusing on processes which allow the maximum level of purity to be achieved in the end product and a minimum amount of residual product; chemistry research aiming to transform those products which do not, or no longer fulfil

a function into raw materials which have an economic value. *(Chemistry Foresight)*
- The development of sustainable industrial systems in agriculture, whereby the options for both integrated and biological (ecological) industrial systems must be investigated. Multidisciplinary programmes focusing on the development of model systems based on biological, technological and socioeconomic research are important here. These programmes must offer scope for strategic research, technical research, knowledge transfer and activities of technical organisations. *(Netherlands Council for Agricultural Research Long-term Perspective)*
- Research into the ecological and socioeconomic preconditions and into the transformation process required for a sustainable economy (business strategies, consumer behaviour, infrastructure and technology). *(Advisory Council on Nature and the Environment Long-term Perspective, Strategy for the Social Sciences)*

INTEGRAL UTILISATION OF SPACE

The extremely dense population in the Netherlands, plus the growing needs of the individual implies that we have very little scope for realising all our ambitions. Over the next few decades the space available will have to be shared out to meet a variety of wishes and interests in the economy, nature, agriculture, housing, infrastructure and recreation. A great deal is being done in this respect. Agriculture is facing a major change, both in an economic sense and in terms of the contribution it must make towards improving the quality of our environment. The so-called Main Ecological Structure (a system of corridors linking natural, uncultivated areas) is being worked upon, outdoor recreation is still on the increase and a substantial expansion of our woodlands and forests is expected in due course. Transport connections, which remain extremely important for the Netherlands as a country which offers attractive business locations for distribution, are under a continually increasing amount of pressure. Choices must be made as to the direction the developments should take, both within and leading from the Randstad and other major urban areas.

> **Intensify research into the integral utilisation of space and into resolving the acute problem of lack of space in the Netherlands.**

The possibilities for a foresight study into spatial research is being looked into in conjunction with the R&D network for spatial planning policy (*Netwerk* RO). The main theme of this study must be intensification of the cycle of generating knowledge, including the attempts to stop the current breakdown of that cycle.

Various relevant research themes were suggested in foresight studies which had already been completed:

- Long-term research into the development of logistic chains, intermodal transport and (collective) passenger transport, a study which should focus on (further) developing the transport system as well as on gaining insight into the utilisation and dynamism of transport systems, the management thereof, and technological solutions for transport problems. A Steering Committee on Traffic, Transport and Infrastructure has already worked out a research programme. *(Steering Committee on Traffic, Transport and Infrastructure)*
- Civil engineering technology research focusing on the intensive utilisation of space and the land-water problems. Challenging concepts such as building underground, the use of recycled raw materials and land redevelopment are being tackled via the ICES (Interdepartmental Commission on Economic Structure) programmes. Sustainable building and urban construction also deserve attention. *(Dutch Knowledge Portfolio Study)*
- Research to obtain insight into the ecological effects and risks of an integral utilisation of space and into the possibilities of intensifying the ecological functions in the case of such utilisation of space. Boosting ecological engineering, such as geochemical engineering, intervening in the country's hydrology and biological soil sanitation are important elements. *(Advisory Council on Nature and the Environment Long-term Perspective)*
- Research into the administrative and societal aspects of an integral utilisation of space focusing on decision-making processes, the integration of legislation and regulations, construction principles, the development of instruments to help assess the effects of physical planning activities in an early stage of the planning process, and the development of non-financial instruments to pursue physical planning and infrastructure policy. *(Advisory Council on Nature and the Environment Long-term Perspective, Netherlands Council for Agricultural Research Long-term Perspective)*
- Research into the effectiveness and efficacy of *spatial investments* and the conditions applying to these investments, devoting particular attention to the nature and the role of land policy, the progress and impact of VINEX (Fourth report (extra) on spatial planning in the Netherlands) and process architecture. *(R&D network for spatial planning policy)*
- Medium-term research into the changing urban and rural area ratios, focusing on the nature of the underlying societal, economic and ecological processes, the impact on society and the environment, and the possibilities for steering policy. A programme has already been worked out by Netherlands Council for Agricultural Research and the R&D network for spatial

planning policy *(Netherlands Council for Agricultural Research Long-term Perspective, R&D network for spatial planning policy)*
- Research into the time-spatial dynamics, focusing on the relationship between changes in how time is spent (24-hour economy, more leisure time, longer opening hours) and the spatial consequences for district planning and urban development, and combined time-spatial trends like teleworking. *(R&D network for spatial planning policy)*
- An integral biodiversity research programme based on work performed by the Netherlands Council for Agricultural Biodiversity Research and Advisory Council on Nature and the Environment programming study. *(Biodiversity Report)*

2.3 Internationalisation and regionalisation

There is a continuous scaling-up and internationalisation under way in the markets for people, services, goods, capital and information. Information technology is constantly offering new opportunities in this area. Several, previously isolated areas of Eastern Europe, as well as some developing countries, have now become economically active. This has led to a rearrangement of the production and employment structures (see box 6), the internationalisation of data flows and the rapid expansion of dominant cultures.

These changes give rise to responses in which the necessity of continuity and cohesion is stressed and in which traditional structures and values are called to mind. The political translation of this is sometimes sought for in the regional context. Extremes which come to the fore in this respect are nationalism, protectionism, and cultural chauvinism.

The national state is sometimes regarded as too small, on other occasions, too large. On balance, it is still loosing its influence. At the bottom, local and regional structures are becoming stronger. At the top, we see an increase in the importance of international arrangements. International economic processes progress more quickly than political and administrative processes. Decision-making is becoming fragmented and this has an effect on the relationship between citizens and local and regional governments.

Since the end of the Cold War, international relations have become fluid and unpredictable given that the players are now searching for new alliances or forms of regional unification. Europe is engaged in the latter, yet at the same time it is forced to reorientate itself with regard to its relationships with neighbouring countries.

Box 6 Internationalisation and research foresight studies

An orientation of our national defence efforts towards continental Europe is no longer sufficient and is being expanded in the form of conflict control, peacekeeping, stabilising intervention, crisis management and combating terrorism. This gives rise to the question whether a different orientation of *defence research* is not required. Re-evaluation of foreign policy calls for a foresight study into *research focusing on the developing countries*. This applies all the more considering the tendency to use the development aid budget to encourage the research capacity in the developing countries themselves. The Advisory Council on Development-Related Research (RAWOO) could take the lead here.

DEVELOPING BUSINESS ACTIVITY AND INNOVATION

One of the questions asked in the process of internationalisation and regionalisation is whether in the year 2010 the Netherlands will still be highly competitive and, if so, what that competitive position will be. The Netherlands Central Planning Office's scenario study,[3] outlines three possibilities to answer that question. Trends in Dutch trade and industry and the relationships with business activity elsewhere are central in that report. Internationalisation calls for a restructuring of Dutch industry. The importance of this process urgently calls for research into the development of business activity, the internationalisation ('globalisation') of business activity and regional profiling, and also research into technological innovation processes in an international, knowledge-oriented society. It is a question of understanding the processes and of developing relevant economic and socio-cultural knowledge which contributes to trade and industry's competitive position.

Encourage research into the development of business activity and into innovation processes in support of the restructuring of Dutch industry.

Foresight studies suggest the following research themes for this.

- Research into innovation processes and knowledge management in international, knowledge-intensive economies, into the role of scientific and technological research therein, and into the consequences for industrial development in the international dimension. Technological development has an influence on the development of business activity and the locations where economic core activities will take place. Contributions can be made from business economics, regional economics, law and technology studies. *(Agricultural Sciences Foresight Study, Working Group for the Social Sciences, Economics Foresight Study, Preliminary Study into Knowledge for the Service Sector)*

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[3] *Nederland in drievoud* (The Netherlands in triplicate), CPB.

- Research into the development of the European market and European economy, the effects of abolishing border controls and the development of new economic opportunities. *(Working Group for the Social Sciences)*
- The juridical aspects of economic internationalisation. There is very little public control of the capital and goods markets at international level. The various government models (EU, NAFTA, Asia) compete against one another, exporting part of their legal systems, including the accompanying value systems. *(Law Foresight Study)*

INTERNATIONAL AND REGIONAL PROCESSES OF CHANGE

Internationalisation and regionalisation not only have an economic side to them; they also involve politico-administrative and socio-cultural aspects. In this process, the various communities become more closely intertwined in an organisational, institutional and cultural sense. The changing international relations give rise to options, questions and uncertainties. These can only be dealt with properly if they are based on insights into international processes, international decision-making and the development of regional and international cultures.

Stimulate multidisciplinary research into administrative and socio-cultural internationalisation.

Major themes for research are:

- Research into the cultural exchange and the development of international culture. Of importance here is research in the humanities and social and cultural research into other languages and cultures. It goes without saying that priority should be given to those languages and cultures which are important for the Netherlands from an economic, political and societal point of view. *(Committee for the Future of the Humanities, Foresight Study into Dutch Language and Literature)*
- Research into development of the Dutch language and culture and into the acquisition of languages and polyglotism. Internationalisation and the multicultural society in the Netherlands are bringing about a substantial change to the Dutch language and Dutch culture. While acquiring and

mastering the Dutch language may no longer be taken for granted it is still very important. *(Foresight Study into Dutch Language and Literature)*

- The development of international legal practice, particularly European legal practice. Europeanisation is attempting to find a balance between a democratic federal structure and a bureaucratic supranational organisation. This gives rise to a new kind of law. *(Law Foresight Study)*

2.4 Quality of life

When, over the years, Dutch people were asked what they felt was the most important thing in life, their answers varied along with their views as to whether the conditions of life are self-evident or, to the contrary, under pressure. Nevertheless, there is one thing that has become increasingly important over the years: our health.

The quality of life is influenced by the developments that take place in society, developments which involve both challenges and threats: individualisation and the ageing population for instance. Individualisation is the process that gives man the freedom to organise his own life, aside from traditional relationships and morals. The welfare state has made a high quality of life possible for a great many people. Moreover, the economic measures that will ensue from the welfare state reforms will also have an effect on the quality of life.

These developments are leading to an increase in the tension between the individual and the population as a whole. Subsequently, that tension can be expressed in a dichotomy in society, in a decline of the 'midfield players', a decline of the family, more insecurity, a general decrease in the social cohesion at macro, meso and micro level. Whatever the (often extreme) expectations and fears may be, it is in any case clear that societal ties and relations follow different patterns. Structural changes occur which are consequential for policy and administration.

SOCIAL COHESION

Social cohesion covers several different aspects: individualisation, the change in societal relations and the role of government. Individualisation not only makes people set high demands on life, but in turn makes life itself set new demands on mankind. The increased freedom to choose can turn into pressure to choose; something which not everyone is able to cope with, and can lead to new forms of exclusion. On the other hand, we see new movements and other forms of social cohesion emerging. The relation between citizen and government changes. On the one hand we have the outspoken citizen who uses acceptable or even unacceptable means in his fight against what he feels are disagreeable government activities. On the other hand we have a government which has to deal with a wide range of different citizens' interests in such a way that its own effective actions are not impeded by those citizens who feel the government has not given them a good enough deal, or who even alienate themselves from the government. Social cohesion as the central theme for multidisciplinary research gained wide support at a conference on strategy for the social sciences.[4]

> **Organise a multidisciplinary research effort into social cohesion, important aspects being individualisation, new societal relations and the role of government.**

Research priorities have to be dominated by the quality of life on the one hand and social cohesion on the other, taking into account the restructuring process of the welfare state. Especially those new trends that can lead to a reduction in the tension between the individual and the population as a whole, should be the subject of study.

- How do people become, and remain able to deal with the constant problem of having to make choices in both their private and their working life? Questions into the intellectual, moral, social and emotional baggage, into learning to learn and life-long learning are important here. These questions must be investigated in relation to raising families, education and the media. *(Working Group for the Social Sciences, Foresight Study into Education Research)*
- The effects that dominant societal institutions (the market and the media for instance) have on the citizen. How, and to what extent is it necessary to protect the identity of the individual and the individual's private life? How autonomous is the citizen? *(Law Foresight Study)*
- Research into maintaining law and order, into decision-making on issues of public administration, and also into the administration of law and equality before the law, can contribute towards new concepts of administration and citizenship: the citizen as a person who governs and is governed. *(Law Foresight Study)*

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[4] *De Sociale Wetenschappen op de Agenda* (Proceedings of the Workshop 'Social Sciences on the Agenda') – 20 March 1996, Foresight Steering Committee / SWR, March 1996.

It is important to conduct research in a wide variety of areas in order to map out the dynamism of the tension between the individual and the population as a whole. The nineties show a new élan in every respect here. Future-oriented research should devote attention to new, sometimes quantitatively negligible movements and innovations. Priorities here are:

- Research into emerging lifestyles based on societal, religious or economic values which cannot (fully) be traced back to traditional socioeconomic personal characteristics. Codes of conduct often develop in these lifestyles which in actuality imply a reduction in the tension between the individual and the population as a whole. *(Working Group on Strategy for the Social Sciences)*
- The effects of flexible labour. Flexibilisation can contribute towards employment and towards resolving the problems of organising economic activity. It can also bring about new forms of exclusion in the labour market and damage the quality of production. *(Working Group on Strategy for the Social Sciences)*

NEW ORIENTATIONS IN HEALTH RESEARCH

The health service has developed into a comprehensive, differentiated and, partly because of this, complex sector of our society. Health and the quality of life are regarded as one and the same by many people. Much sooner and more frequently than before do people now resort to the health care system in the expectation that the quality of care has been adapted to state-of-the-art technology and science. Resorting to the health care system has also become more intense because of the ageing population and the increasing number of chronic illnesses. This results in an increase in costs. People are becoming older, become sick for longer periods of time (an increase in chronic diseases) and are more likely to suffer several ailments at the same time (co-morbidity). The number of chronic diseases is also increasing because of the improved treatment of acute pathological illnesses.

Effectuate the new priorities in health research focusing on the 'quality of life' and the efficacy of the health service.

The problems outlined above lead to five priorities in health research:

- Optimisation of diagnostics and the treatment of *chronic or chronically recurrent illnesses* that can occur at any age, are difficult to treat, have a radical effect on the quality of life, require a great deal of care and for which scientific research is promising. Some illnesses have a psychological basis, such as behavioural disorders in children, depression, schizophrenia, drug addiction and communication disorders (including language deficiencies). Other illnesses are physical (somatic) by nature: multiple sclerosis, chronic pain, chronic intestinal inflammation and congenital disorders. The consequences of micro-organism resistance to antibiotics could also be added to this list.

- *Geriatric complaints and limitations inherent in the elderly* which result in a lower quality of life and a substantial need for care. This calls especially for research into the endocrine aspects of ageing, dementia (including Alzheimer's disease), cerebrovascular complaints, hearing defects, poor eyesight, heart complaints, incontinence and co-morbidity.
- *Primary and secondary prophylaxis,* such as research into new prophylactic methods, effectiveness and efficacy studies of existing prophylactic measures, research into the implementation of prophylactic measures. Of importance here are the organisational, the social and the ethical aspects of prophylaxis. Research in the broad field of the determinants of (ill) health and genetic predisposition should also be stimulated.
- *Promoting autonomy and the ability to cope*: care tailored to meet the needs of the individual. Top priority is given to research which helps (chronically) sick and handicapped persons to live their lives as independently as possible, giving attention to the social environment: the development of home care technology, research into the applicability thereof in extra-mural care and into the determinants of how health is experienced.
- *The quality and efficacy of care.* Top priority is given to medical technology assessment (MTA) and methods of evaluating existing diagnostic practices and treatment, also in the field of surgery, focusing on the development and implementation of protocols. Research is also necessary into the side-effects, complications and interactions of the long-term use of medicines, into the effects of multi-medication and into a responsible reduction in the use of medication. With regard to the quality and efficacy of the care system attention is required for research to support the Care Institutions (Quality Act), into issues connected with substitution, into the coordination of different kinds of care (particularly for those in chronic need of care) and into the consequences of a changed employment structure in the health service. Also of importance in relation to quality and efficacy of the organisation is research into the diagnostic decision-making process, into the added value of a great deal of laboratory diagnostics, into the various ethical aspects at issue in medical decision-making, and into the care demand and supply ratio. *(Working Group on the Strategic Conference on Health Research)*

3

STRATEGY FOR SCIENCE

Intensifying research into the needs of society only makes sense if the research system itself is in order. Numerous suggestions were made in the foresight studies for improving the organisation of research. Key concepts are: profiling in terms of quality, raising the level of strategic orientation and intensifying collaboration. Some areas are more advanced than others in this respect, although the processes leading up to it have already been started in all fields.

How these key concepts will be interpreted will differ in each field of science since the demands and possibilities differ for each field. The organisation of and strategies in research (to benefit both scientific and societal progress) must always be in line with the characteristics of each discipline. This chapter deals with those strategic questions which are of relevance to the four major disciplines: engineering and the natural sciences, social sciences and the behavioural sciences, the humanities and health research. Recommendations are then made on the basis of foresight study results in these fields to reinforce the self-organisational capacity of these disciplines.

3.1 Engineering and the natural sciences

Engineering and the natural sciences are major factors for the innovative strength of our industry and our service sector and for the attractiveness of the Netherlands as a place to establish a new business. Research in the field of engineering and the natural sciences is also important for societal issues such as environmental problems and the problems we in the Netherlands have to face due to our lack of space. The quality of fundamental research provides the Dutch economy with a competitive advantage. Therefore the Foresight Steering Committee participated in, or initiated (see box 7), a large number of foresight studies or foresight activities for engineering and the natural sciences.

The Foresight Steering Committee foresight studies show that engineering and the natural sciences are faced with several demands of an institutional and organisational nature. The drop in number of students puts pressure on the progress and quality of research in physics and astronomy, mathematics and chemistry as well as in other disciplines. This is a global trend which is all the more apparent in the Netherlands because of the demographic effects. Secondly, the main developments in the engineering sciences occur in subjects which go beyond the boundaries of the traditional areas. These generic technologies are of particular importance for the development of high-tech industry. Finally, the fact that the borderline separating research in the natural sciences and research in the field of the engineering sciences is becoming progressively less defined, also gives rise to other questions.

Box 7 Foresight studies in engineering and the natural sciences

▸ *Foresight studies*

Mathematics foresight study
Chemistry foresight study
Foresight study into Energy Research
Foresight study into Earth Sciences
Foresight study into Agricultural Sciences
Computer Science foresight study
Foresight study into Agricultural Sciences in the year 2010 and the position of Wageningen Agricultural University
Netherlands Council for Agricultural Research Long-term Perspective
Advisory Council on Nature and the Environment Long-term Perspective
Steering Group on Traffic, Transport and Infrastructure
Technology foresight into Production Technology

▸ *Background studies*

The importance of engineering and the natural sciences
The Dutch Knowledge Portfolio in the field of engineering and the natural sciences and the main fields of technology
A Technology Map for Dutch Business

Agricultural Scenario Study
Chemistry Scenario Study
Scenario Study into Transport and the Infrastructure
Nature Research Scenario Study
Scenario Study into Earth Sciences

Physics in the Netherlands
Mathematics in the Netherlands
Biology in the 21st Century
Knowledge for the service sector
Nanotechnology background study
Investigative study into Microsystem Technology
Preliminary document on Aviation Technology
Preliminary document on Space Technology

The Central Planning Office's scenario study, *Nederland in drievoud*, shows quite clearly that production internationalisation and the more stringent requirements with regard to environmental impact and energy consumption call for a radical restructuring of Dutch industry, focusing on sustainability and the development of high quality market segments (see box 5). Chapter 2 suggests several themes for research which could contribute towards this restructuring process. Research in the field of engineering and the natural sciences is essential for the development of high-grade products in the traditional sector and the processing industry, and to reinforce the high-tech sector. Boosting the orientation of research into industrial options and needs is therefore necessary.

The restructuring of industry is already perceptible in high-tech sectors such as electronics, the motorcar and aircraft industry and also in multinational companies operating in the processing industry. In these sectors internationalisation leads to a reallocation of activities and sometimes to the disintegration of production. Reallocation coupled to restructuring gives rise to questions relating to the future of Dutch research in the field of engineering and the natural sciences, focusing on these activities. We must not forget that internationalisation also creates opportunities for (new) knowledge-intensive activities. The available research potential will retain its value if strategic reorientation contributes towards the preservation and development of such new activities.

The point of departure is a good one. Evaluations show that fundamental research in the field of engineering and the natural sciences is of a high standard when looked at in the international dimension. A profiling and collaboration process is under way in these disciplines, making it possible to maintain this international quality. Nevertheless, the foresight studies show that the degree programmes for junior researchers are still often too disciplinary and the change-over to multidisciplinary applications is still too great. The high-tech industries still benefit far too little from the quality of fundamental research. A role is set aside here for intermediary organisations, for the Netherlands Organization for Applied Scientific Research, the principal technological institutes and the universities.

This process of profiling and collaboration will need to be continued, intensified and accelerated. This can be achieved by:

- Setting out a profile of each institute and thus internationally promoting highly acclaimed research at the expense of research which scores lower, when, and in so far as that research is not essential for sophisticated initial degree programmes.

- More intense research collaboration in research schools among the institutes and among the research schools themselves.
- The institutes devoting more attention to multidisciplinary research, and by giving this research more attention in the assessment systems of such intermediary organisations as the Royal Netherlands Academy of Arts and Sciences, the Netherlands Organization for Scientific Research and the Association of Universities in the Netherlands.
- Temporary extra support on the part of the minister of Education, Culture and Science to encourage the retirement of senior researchers, promoting new talent and attracting talent from abroad.

Research in the field of engineering and the natural sciences determines the profile of a university. Both this research and the closely interwoven training in these fields in initial degree programmes and postgraduate programmes is essential for a whole range of other disciplines, from medicine to philosophy. Given that proficiency standards are becoming increasingly higher, particularly in engineering and the natural sciences, institutes will need to collaborate more in initial degree programmes by organising specialists' exchange visits to benefit the quality of these programmes. Differentiation is also required for the same reason: instead of, or in addition to the four-year initial degree programmes, all universities should be able to offer a five-year programme in preparation of a postgraduate programme or specialised professional practise in a different sector of the labour market.

The Foresight Steering Committee therefore concludes that in addition to the priorities that come to the fore in these foresight studies in terms of content, the engineering and natural sciences are faced with the task of reorienting their research and of profiling each individual institution. It is of the utmost importance that this is done in good time so as to prevent destruction of capital. The Foresight Steering Committee has requested the Royal Netherlands Academy of Arts and Sciences to set up a committee to look into the future developments in university research in engineering and the natural sciences. This committee should be assigned with the task of mapping out the qualitative and quantitative national and international trends, analysing the strategic options presented, and of drawing up an offensive plan of action. Such a plan of action, in which the content of research and education, the supply and demand factors, as well as the organisational, staffing and financial conditions should be looked at as a whole, should be completed before the end of 1996.

3.2 Social and behavioural sciences

More fundamental research relating to the most important developments and steering processes in society is of the utmost importance for the quality of society-steered research in the field of the social sciences. To achieve this requires the involvement of all the social sciences.

Box 8 Foresight studies in the social and behavioural sciences

- *Foresight studies*

Law Foresight Study
Economics Foresight Study
Educational Research Foresight Study
Cognitive Sciences Foresight Study
Working Group on Strategy for the Social Sciences

- *Background studies*

Scenario Study for Law
Scenario Study for Educational Research

Human capital
What do we know about communication?
Dilemmas, steering and spontaneity in economics
What will be the course of justice?
Cognition: science, technology and the social framework
Towards a foresight study into educational research

The Working Group on Strategy for the Social Sciences was set up in consultation with the Social Science Council for the purpose of acquiring more insight into the social sciences as a whole and into the possibilities of taking an approach from the angle of steering processes. The so-called 'steering processes' analysed by the working group were discussed at the 'Social science on the agenda' conference held on March 20th 1996. The results are given in the table on page 41.

The working group based its choice of steering processes (technological developments, internationalisation, restructuring of the welfare state, diversification of the life course) on the contributions at, and the results of, an earlier conference organised by the Social Science Council in collaboration with the Section of Social Sciences of the Royal Netherlands Academy of Arts and Sciences, and the Netherlands Organization for Scientific Research Council for Social and Behavioural Sciences in November 1993. Also used to make that choice were a series of interviews held among the users of knowledge and an extensive analysis of the literature. With a view to the limited amount of time it had and the limited amount of expertise available, the working group focused on the social sciences. The processes chosen were not the only ones conceivable, nor do they exclude each other; they are however the most often mentioned processes. The names given to the processes in the table have been formulated as loosely as possible so that they each cover several constituent processes. 'Technological developments' for instance covers more specifically the 'informatisation of society'. 'Internationalisation' has a counterpart in 'regionalisation'. Demographic developments also have a substantial influence on society. These are now given special attention in the studies conducted by the Netherlands Interdisciplinary Demographic Institute and in the framework of the Netherlands Organization for Scientific Research priority programme 'Population issues'.

The approach chosen for here allows the definition of fascinating, multidisciplinary research themes which call for specifically programmed efforts and contributions from the different social sciences in the long term (at least five years). The working group used the results of foresight activities in the field of the social sciences on which to base their choice of research themes (see box 8). These themes are human capital, the development of business activity, social cohesion and environmental issues.

Jointly, these processes and themes offer a good analysis framework for research to be undertaken in the field of the social sciences in particular. An obvious fifth theme, 'well-being and health', is discussed in § 2.4 and 3.4, but this will also need to become a leading theme for the social and behavioural sciences. It must be noted that the behavioural sciences were still not given sufficient consideration when establishing these themes. This will need to be given more specific attention in future foresight activities. The behavioural sciences have already been taken into consideration in foresight studies in the cognitive sciences.

Whereas the thematic approach offers good opportunities to capitalise on the new élan in research in the field of the social sciences (and the time is ripe for this) the organisational and structural conditions must still be in place. We often see concern being expressed in the foresight studies, the background studies and in the report drawn up by the Working Group on Strategy for the Social Sciences about continuity in social science research. Concern is also expressed about the link between contract research and the fundamental

	QUALITY OF LIFE			
Research themes/ Steering processes	Human capital	Industrial development	Social cohesion	Environmental issues
Internationalisation	• Comparison of the economic returns of different educational and training systems • Adaptation of the educational system to international requirements	• Comparison of industrial development with that elsewhere • Relocation / regionalisation of Dutch businesses • Relations between national governments / international trade and industry	• Solidarity in a multicultural society • Social and spatial segregation of groups of different national origins	• Cross-border environmental impacts
Technological development	• Economic returns of study programmes • Bringing education into line with demands of knowledge-intensive technological developments • Utilisation of communication and information technology in teaching	• Specialisation in Dutch trade and industry in knowledge-intensive industries	• The consequences of new media and technology for social contacts • New social inequality due to labour regradation and degradation • Social and spatial segregation of the ignorant and the knowledgeable?	• Social conditions for the effectiveness of technological solutions for environmental problems • Re-equipping housing and transport with new communication and information technology
Welfare state reforms	• The consequences of cuts in government funding for selection and educational opportunities	• The effects of supranational (European) regulations • The social and legal position of citizens in the changing international economic system	• The significance of the social mid-field for solidarity • The position of our social security system in the international perspective • How is solidarity among rationally calculating citizens possible?	• The effectiveness of non-coercive arrangements: environmental policy as a model for new forms of steering • Detecting cultural factors which can contribute towards self-regulation and sustainable consumption
Diversification of the life course	• Recurring education • Returns from education later in life • Build-up of human capital in professional career / breakdown in family life career	• Careers between and within international companies • Diversification of the course of life and social security claims	• The consequences of shifting transitions in the course of life for income equality • Social situation of the elderly	• The consequences of changes in the structure of households for housing and transport problems

Source: *Een strategie voor de sociale wetenschappen; eindrapport* (A strategy for the social sciences; final report), Working Group Strategy for the Social Sciences (under preparation)

insights the social sciences really have to offer, particularly when brought together in a multidisciplinary context.
For that matter, at least for the time being it is evident that there is little reason to create new, permanent structures for this purpose. What is necessary is that we have new organisational stimuli in order to really do justice to the choice of theme. It is necessary that:

- an integral, multidisciplinary approach regarding research themes is given priority above fragmented, disciplinary projects;
- there is close involvement of departments and other users of knowledge in the programming and evaluation and, where there is a direct interest in the research, in financial contributions;
- the funding should strengthen the ties between research in all three flows of funds (government funded research; grants from the Netherlands Organization for Scientific Research; funds raised through contract research);
- a long-term commitment is entered into.

The Foresight Steering Committee suggests that a clearly identifiable and purposive programme support be organised for the themes of Social Cohesion and Human Capital. This could be achieved through specific programmes set up by the Netherlands Organization for Scientific Research in which the conditions mentioned above would be realised, i.e. multidisciplinarity, integration of the different methods of funding and contributions from the demand side. Thanks to their structure and innovative procedures, these programmes would function as a test case for the new élan in the social and behavioural sciences.

ACCESSIBILITY OF DATA BASES

A second necessary improvement of the preconditions is better accessibility to existing research results and data bases. The computerisation of societal processes generates large amounts of (international) data which, assisted by information and communication technology, can become relatively easy to access. This opens up new opportunities for science. Many different kinds of research can thus be conducted at relatively low cost. Use of the *same* data bases for *different* disciplines creates numerous opportunities for multidisciplinary collaboration. There is already a good infrastructure available in the Netherlands (SURF, Expertise centres, Steinmetz-Archief, scientific statistics agency); the thing to do now is to make better use of them. The longitudinal data of non-university institutes such as the Netherlands Central Statistical Office and the Social and Cultural Planning Office, should also be accessible.

Data which is routinely collected in societal organisations and societal processes fail to conjoin without the stimulation of innovative, methodological research. A provisional, extra incentive for such research within the framework of the regular disciplinary programmes of the Netherlands Organization for Scientific Research is only logical. Investments to build up a data infrastructure should be given an appropriate place in the larger multidisciplinary programmes such as the ones advocated elsewhere in this report for the social sciences.

3.3 The humanities

The Netherlands is a multiform society which is in close contact with other societies. The importance of the humanities for our nation is therefore almost self-evident. Research in the humanities covers, among other things, history studies, language, religion, art and literature, the development of ideas and the development of norms and values in different societies. Chapter 2 sets out the various themes for research in which the humanities are able to make a useful contribution.

Box 9 Foresight activities in the humanities

- *Foresight studies*

Modern Languages Foresight Study
Art History Foresight Study
Committee for the Future of the Humanities

- *Background studies*

Foresight studies in the Humanities; opportunities and limitations of science policy
Research in the Humanities
Dutch Language and Literature

However, research in the humanities has taken a downhill trend since the nineteen eighties. The causes of this problem are:

1. cuts made in the arts faculties almost continually;
2. the funding of research in the humanities, both from the government and within universities themselves, is in fact based on the number of students;
3. there is an imbalance in students' interest for the various study programmes;

4 (national) coordination is lacking for the development of certain areas and the scaling-down of arts faculties (apart from the Minor Arts).

Three objectives for policy on the humanities were formulated in the Foresight Steering Committee's interim report:[1]

- to resolve the problems in the humanities that were outlined in the available foresight reports;
- to boost society's support for the humanities;
- to look into society's needs for research in the humanities.

The report published by the Committee for the Future of the Humanities (the Vonhoff Committee)[2] puts forward several solutions for these problems. The Foresight Steering Committee would like to bring these solutions to the attention of all concerned yet again. New study programmes have been introduced in the arts faculties in response to the decreasing budget and the government's wish to improve coordination between university programmes and the labour market. A distinction should be drawn in policy on the humanities between these and the 'traditional' arts study programmes. The former can often be funded on the basis of student numbers. Funding of the latter, and thus the interwoven research, may never be solely dependent upon student numbers. The second important recommendation made by the Committee for the Future of the Humanities is related to national coordination. To prevent the further fragmentation of unique research specialisations and library collections – the 'research equipment' for scholars in the humanities – and to make specific reinforcement of the basis of the humanities possible, it is essential that a national chair policy be established and that library policy is coordinated.

Both the government and the institutional world will need to assume responsibility and make an effort to implement these recommendations and also to reinforce the core of the humanities. The Minister of Education, Culture and Science in particular has a role to fulfil in this field. The message for the government is that (also) research in the humanities has a certain price tag. That price does not depend on the number of students and cannot simply be established and earned on a 'market'. From within its cultural and political responsibility the government may be expected to support (sections of) the humanities. The government's cultural policy has the objective of promoting cultural multiformity. Promoting research in the humanities is also appropriate in that policy.

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[1] *Koersen op kennis* (Setting course for knowledge), Foresight Steering Committee, May 1994.

[2] *Men weegt kaneel bij 't lood* (Cinnamon is Weighed by the Dram), Committee for the Future of the Humanities.

There is a pressing need for more intense strategic orientation in and better collaboration among institutions. Institutions are consequently faced with the challenge of using the success of new study programmes to maintain the fundaments of the humanities. This is justified since the quality of new study programmes also depends on a healthy research core in the humanities. Specialisations can always emerge from a healthy core and allow the humanities to become more geared towards the societal needs for knowledge in the field of the humanities.

The Vonhoff committee report requested by the Minister of Education, Culture and Science was concerned chiefly with the more general problems in the field of research in the humanities. A different kind of foresight study is required for more specific statements on the orientations in terms of content in this research. In the little time it had left, the Foresight Steering Committee has arranged for this in at least one key area of the humanities in the form of an international comparative study into research to benefit the mother tongue.

DUTCH LANGUAGE AND LITERATURE

One of the key subjects for the humanities in the Netherlands is without doubt research into Dutch language and literature. Essential specialisations (virtually) disappeared in this field too because of the constant cutbacks. A study into research into Dutch studies – in which a comparison was drawn between the language and literature courses in the mother tongue given in Denmark and North Rhine-Westphalia – shows that Dutch language and literature courses are offered without adequate (research) formation. Other gaps that stand out in this comparative study are:

- the lack of quality and quantity in digital corpora;
- the limited quality and quantity of handbooks and standard works;
- the relatively poor research and library facilities.

The second point of concern is that research in Dutch studies has lost its traditional ties with important sectors of the community such as (secondary) education and the 'literary system'.

Here too, improving the position of Dutch language and literature studies is not only the government's responsibility, it also calls for an effort from the researchers. Strengthening the societal position of the field is only possible if researchers do all they possibly can to ensure the transfer of results and that they themselves initiate research on important themes like education in one's own language and literature, multicultural developments and computer aided communication. The conclusions of the strategic conference organised by the Netherlands Organization for Scientific Research on the 19th of April 1996 made significant moves in this direction.

3.4 Health research

Health research, according to a definition set out jointly by the Council for Health Research, the Council for Medical Sciences and the Medical Committee of the Royal Netherlands Academy of Arts and Sciences, covers medico-biological, clinico-scientific and health *care* research. This definition, which has the consensus of the field, is used in this report.

INVESTIGATED SECTORAL AND TRANS-SECTORAL FIELDS

The health service is treated in this report as a sector with its own interests in research. Health research also has an inherent relevance to society since it aims to contribute towards a better health service and thus a better state of health and quality of life (see also § 2.4).

This relevance is reinforced through the close relationships between research, medical faculties and academic hospitals. Thanks to this relationship, a part of this research is conducted in an environment which is both stimulating in the scientific sense as well as being geared towards the practical situation. The significance for society is emphatically reflected in the research priorities. Nevertheless, while the Netherlands has a well-developed advisory system in place there is still insufficient attention given to the relationship between health and societal aspects such as the environment, technology, employment and social security in the advice it puts out. In this report the Foresight Steering Committee also devotes attention to the importance of research for the education and training of medical school graduates, specialists and researchers as well as to the importance for allied sectors (pharmacy, medical technology).

Obviously these proposed research priorities should entail the realistic expectation that an improvement in health or in care will depend on specific research. Also, the state of science should be such that there is reason to expect applicable results in a relatively short term. A Council for Health Research/Foresight

Steering Committee working group, given the name of STRAC (Strategic Conference on Health Research), has deliberated upon which options in the field of health research should be encouraged in the light of the needs of individual stakeholders in the health service. A report of the Royal Netherlands Academy of Arts and Sciences[3] gives an overview of the recent developments in medical research (from fundamental to applied research) which are important for the health care sector to function properly.

Box 10 Foresight activities in health research

- *Foresight studies*

Medical Technology Project Group
Strategic Foresight Study into controlling the risks for health and safety at work and socio-medical supervision
STRAC working group
RGO Long-term Perspective

- *Background studies*

Scenario Study into Health Research

Disciplinary Advice on Health Research 1994
Foresight into the Future of Public Health
Strategy Paper 1996-2000 NWO Council for Medical Sciences
Background Study into the Supply and Demand in Health Research
Prevention of Sick Leave and Invalidity

DEVELOPMENTS IN HEALTH RESEARCH

Health research is very much influenced by scientific and societal developments. On the one hand, discoveries in scientific research do offer possibilities for innovation in the prevention and cure of disease and the care for sick people. On the other hand, research initiated from within the care system itself is able to increase the effectiveness and efficacy of that system.

The rapid development of medical technologies has a great influence on many areas and the number of possibilities would seem limitless. From a medical point of view these technologies offer opportunities to improve care in the field of diagnosis, the treatment of and care for patients. They still have their problems however and are always inextricably linked to debates on health service costs and quality and ethical issues. Some new technologies expand enormously, giving rise to a great deal of indirect expenditure for nursing and laboratory services. Numerous questions as to the ethical boundaries of medical intervention have led to the emergence of medical technology assessment (MTA) and medical ethics.

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[3] *Discipline-advies Geneeskunde 1994* (Disciplinary Advice on Health Research 1994), Royal Netherlands Academy of Arts and Sciences.

A new field is molecular biology, which studies the relationship between the structure and the function of macromolecules in living nature. A great deal is expected of this field now it has become possible to research the functional consequences of molecular change. Medicine (especially genetic research) is one of the most important areas of application for such research. The molecular development of drugs can lead to new categories of useful substances. The application of specific designing now makes it possible to save both time and money. The pharmaceutical industry could benefit from this.

The various institutions all have different research tasks to fulfil within the field of health research in the Netherlands: each focuses on that field of research it is most proficient in. Agreements at local level are being reached between the faculties of research institutes and academic hospitals on the main items for research and the coordination of priorities. According to the Foresight Steering Committee the next logical step is a parallel division of tasks among the academic hospitals in terms of top reference tasks and priority care tasks. This will benefit the quality of the care provided since it will also boost the link between good scientific research and concentrated experience.

EDUCATION AND TRAINING

We can distinguish separate degree programmes here: trajectories for medical school graduates, medical researchers and physicians for the care sector. With a view to collaboration with other disciplines for the development of a critical scientific attitude, all three trajectories call for sufficient interest in resolving medical problems, a broad knowledge and skills. However, the Foresight Steering Committee detects the following two problems.

The first relates to the limited number of opportunities for research in the study programme curriculum for medical school graduates; research which forms the very basis of education and training in this field. Here we see a certain field of tension between the indispensable critical scientific training and the problem-solving attitude which practising physicians must have to enable them to practise their profession. The amount and extent of depth can differ for medical school graduate programmes, specialisations and researcher study programmes. To ensure that lecturers keep in touch with the latest developments it is essential that they carry out ground-breaking research.

The second problem is connected with the inadequate intake of medical researchers in the basic subjects. That physicians are involved in teaching the basic subjects is not only essential for the programmes but also for the indispensable collaboration between the pre-clinical and clinical stage. Since neither the status nor the income of medical researchers is all that high, medical school graduates are more likely to choose a postgraduate programme in the care sector.

The Foresight Steering Committee is of the opinion that the programmes must be intensified. On these grounds the committee recommends that:

- the curriculum should be more scientifically-oriented;
- lecturers should be able to perform fundamental research 'at the frontiers of knowledge', not only in the trainee research assistants programmes but also in the study programme for medical school graduates;
- in future, physicians must also be employed as members of staff for the basic subjects; to ensure of this the career perspectives for junior researchers should be improved in relation to the status and income of those working in the patient care sector.

MEDICAL TECHNOLOGY

The Foresight Steering Committee regards the medical technology sector as an important economic activity (see also § 2.2). This relates among other things to imaging and image processing in diagnostic processes. The Foresight Steering Committee feels that the effectiveness of both new and existing methods should be evaluated. In this connection, the government should assume financial responsibilities early on in the development trajectory, at least at an earlier stage than is the case at present. This also applies with regard to drug development. After all, it is extremely difficult to influence the dynamics of a technology in the final stages.

According to the Foresight Steering Committee it is essential in the field of biomedical technology to achieve better collaboration between the technical and medical faculties in order to remedy or reduce the problems related to an ageing population. It is becoming more important to make use of technological developments in teaching, among other things in connection with diagnostics. The Foresight Steering Committee feels that the development of technologies for use in the home by elderly users with a handicap, such as poor hearing, poor sight or limited movement, should be strongly encouraged. Extra attention is also required for ergonomic applications.

PHARMACY

There is a great deal of expertise in the field of pharmacy available in the Netherlands; this expertise should be utilised better by the pharmaceutical industry. If this is unsuccessful in existing businesses, we recommend that new industrial activities be stimulated. It is quite remarkable to see that the knowledge centres have the majority of the contacts and contracts with industries abroad. The New Drug Research Foundation was recently established by the Ministry of Economic Affairs and the industry in order to try - in concert with the Ministry of Education, Culture and Science and the Netherlands Organization for Scientific Research - to improve utilisation of the knowledge available in the Netherlands.

LABOUR, HEALTH AND SOCIAL SECURITY

Formulation of the problems for research to benefit labour, health and social security has become so fragmented that there is now very little coordination of these research activities. This has resulted in the lack of a multidisciplinary infrastructure, an infrastructure which is of the utmost importance for research in this field. The (meanwhile disbanded) Committee for Research into Health at Work (CARGO) established that interaction between the second line (including researchers) and the first line, which focuses directly on the care aspect (medical examinations, prevention and labour conditions), is deficient.[4] This implies that the *ARBO-diensten* (occupational health and safety services) are deprived of the latest information, giving rise to the impression that the researchers are inadequately informed as to the problems on the shop floor. Consequently, attention should be devoted to the Council for Health Research programming study.[5] This study brings to the fore a large number of research questions based on an extensive round of consultation in the field. Many of these questions relate to problems of implementation. The Foresight Steering Committee supports the suggestions made in this study for a cohesive research programme. ZON[6] could be given a role in the execution of such a programme.

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[4] *Strategische verkenning tweedelijns infrastructuur ARBO-risicobeheersing* (Strategic foresight study into second-line infrastructure for controlling the risks of occupational health and safety), CARGO, November 1994.

[5] *Programmeringsstudie ARBO-risicobeheersing en sociaal-medische begeleiding* (Programming study into the control of occupational health a safety risks and socio-medical supervision), RGO, April 1996.

It is remarkable to see that in comparison with the high political priority given to this theme very little research has been conducted into the macroeconomic links between labour, health and social security. In line with the recommendations made by Den Butter[7] the Foresight Steering Committee urges the government to stimulate quantitative macroeconomic research into the links between labour, health and social security. Research must also be carried out into the effects of regulations.

With a view to the societal developments in the field of labour, health and social security, the Foresight Steering Committee feels it essential that the Government, the Ministry of Social Affairs and Employment, takes the stand as the 'owner of the problems'. Separate organisations have always been unsuccessful in doing this. The Foresight Committee therefore suggests latching on to the current situation for the necessary structural improvement. To ensure continuity of those functions which have yet to be distinguished, the Foresight Committee recommends the following:

1 the Council for Health Research should be assigned to *intensifying the establishment of those priorities* that take the demand side into consideration;
2 *promoting coordination between the first and second line* (occupational health and safety services and research, respectively) can be taken care of by Dutch Care Research (ZON), and where necessary, in collaboration with the Netherlands Organization for Scientific Research;
3 *the coordination and quality of research* could be guaranteed in a research school (a newly established one if necessary) consisting of the most eminent university and non-university institutions, whereby the Royal Netherlands Academy of Arts and Sciences would be responsible for quality control;
4 the function of *national and international liaison office* could also be assigned to such a research school.

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[6] *Zorgonderzoek Nederland (ZON)*, Dutch Care Research, a new organisation established by the Minister of Health. This organisation is in charge of programming and financing research and development for health care.

[7] *Arbeid, gezondheid en sociale zekerheid: Preventie van ziekteverzuim en arbeidsongeschiktheid, en de sociale zekerheidsspiraal – een modelmatige economische analyse op macro-niveau ten behoeve van de Overlegcommissie Verkenningen* (Labour, health and social security: sick-leave and disability prevention and the social security spiral – a model economic analysis at macro level for the Foresight Steering Committee), F.A.G. den Butter, M.P. Pradhan; Foresight Steering Committee, March 1995.

Section B

SUMMARY OF THE INDIVIDUAL FORESIGHT ACTIVITIES

FOREWORD

In the four years of its existence the Foresight Steering Committee has received much cooperation from many, many people. Hundreds of people from the supply and demand side made a contribution; each wishing to participate and help organise, occasionally take part in heated discussion, present their written contributions and comment and criticise. This process has resulted in many initiatives being taken and in the establishment of several new forms of collaboration.

The main insights and conclusions of the foresight process were explained as a whole in Section A of this report. These interrelated and comprehensive conclusions were based on some thirty individual foresight activities, some of which were substantial, others more modest. All in all they produced a wealth of information and insights into the development of the supply of and demand for knowledge in a wide range of research fields.

This section of the report offers a selection of the main points covered in that material, offering a brief summary of the 31 individual foresight activities. Each summary outlines the background, the method adopted and the main results. They also include the comments of the Foresight Steering Committee as the coordinating body.

It is impossible for these brief summaries to do justice to the wealth of ideas and perspectives these activities produced. Nevertheless, they will serve to provide the reader with a good idea of the problems, the solutions and the opportunities in view at this point in time in the fields of research concerned, as well as those expected to come into view in the future.

Assuming that a description of these activities can be of advantage for non-Dutch players in the field of scientific research, the Foresight Steering Committee decided to have these descriptions translated into English.

B 01

PHYSICS

BACKGROUND

In the Netherlands, research in the field of physics, as well as in other scientific disciplines, is a strong support for industry and the service sector. It is also significant for tackling societal issues like energy and environmental problems. The quality of fundamental research in engineering and the natural sciences offers a competitive advantage to the Dutch economy.

What is needed to maintain and boost both the quality and the societal return from physics? This question was the point of departure for the Foresight Steering Committee to initiate foresight activity in this field. In it, a great deal of attention was devoted to the future trends regarding the demand for knowledge in physics.

APPROACH

Towards the close of 1993 the Foresight Steering Committee commissioned a paper to serve as a basis for discussion with the users of physics research in trade and industry and in other areas too.[1] Some of the insights obtained on the future of physics research in the Netherlands will be discussed in brief below.

RESULTS OF THE FORESIGHT ACTIVITIES AND THE STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

It is widely agreed that in the Netherlands physics must continue to deliver adequate expertise for the multinationals established here. Research should also be sufficiently broadly-based for it to help generate new industrial activity and – because of its quality – attract foreign companies. The Foresight Steering Committee calls for a continued shift in funding from subatomic physics to fields which have a greater societal appeal, e.g. phenomenological physics and – in a multidisciplinary sense – nanotechnology.

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[1] *Natuurkunde in Nederland* (Physics in the Netherlands).

Customers of physics research would not only like to see a stronger multidisciplinary orientation but also study programmes becoming more multidisciplinary oriented. They would also like to see an attitude geared more towards problem-solving (engineering physics); the aspect of employment also plays a role here. The disappearing line between physics programmes available at the universities of technology and those provided in general physics faculties should be re-established.

The shrinking size of physics faculties, resulting from fewer students, and the increasing cost of equipment make national coordination of university physics research even more necessary. A key role here is set aside for the Foundation for Fundamental Research on Matter, a division of the Netherlands Organization for Scientific Research which attaches a great deal of importance to a high level of interaction with the demand side in its research policy. Yet the universities too will also need to focus more on an unambiguous allocation of tasks, profiling and new forms of collaboration.

The challenges facing engineering and the natural sciences are to some extent common challenges and must be looked at in their entirety. To this end the Foresight Steering Committee requested the Royal Netherlands Academy of Arts and Sciences to set up a committee that will draw up a plan of action in the short term for the engineering and natural sciences, based on an analysis of international and national trends and strategic options.

B 02

CHEMISTRY

BACKGROUND

A foresight study into chemistry research in the Netherlands had already been placed on the agenda of the Foresight Steering Committee when it was founded in 1992. The committee soon discovered that a study in this field was widely in demand.

APPROACH

The Chemistry foresight study was the first mature foresight study to be performed along the lines of the model established by the Foresight Steering Committee, a model which is characterised by two points of departure. The first focuses on coordinating the demand for knowledge and the supply of knowledge in a specific field (in the future perspective). The second entails working on the basis of 'scenarios of the environment' of that field to be able to predict potential trends and uncertainties in the development of supply and demand in a wider context.

The Royal Netherlands Academy of Arts and Sciences offered to organise the chemistry foresight study and subsequently set up a Chemistry Foresight Committee for this purpose. This committee selected three sub-themes for further analysis from the assignment it had been given, namely: the relation between chemistry and society; the desired developments in the knowledge infrastructure and the training infrastructure; methods of collaboration.

FINDINGS AND RECOMMENDATIONS OF THE CHEMISTRY FORESIGHT COMMITTEE

The following developments, decisive for chemistry research, emerged from the scenario exercises:

- chemistry's key role in the ongoing incorporation of 'the environmental factor' in economics;
- a further reduction in the amount of time needed from a product's conception up to its marketing;
- intensification of interaction between universities, research institutes, the government and trade and industry;

- the growing necessity to concentrate university research and education for the purpose of maintaining quality.

Partly in the light of these and other trends, the Chemistry Foresight Committee named six sectors in its foresight report in which industry and society's demand for chemistry research will specifically manifest itself in the Netherlands. These sectors are: materials; consumer goods; foodstuffs, tobacco and alcohol; health; the environment and sustainability; energy.

With this in mind, the committee calls for a concentration of up to 75% (currently 50%) of public-funded research in the following areas of research: design/synthesis; structure/function; catalysis; molecular life sciences; biotechnology; process technology. According to the Chemistry Foresight Committee the remaining 25% of public research funds should continue to be reserved for autonomous developments in fundamental chemistry research.

Among the other recommendations concerning university education in chemistry is the inclusion of science subjects in the arts and social science studies and measures to increase the student intake level. One important recommendation regarding the organisation and programming of research is the establishment of a National Chemistry Council. Representatives of both the supply and demand sides of research should join forces and work together in such a council to achieve the much-needed concentration of research efforts.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The Foresight Steering Committee regrets that the chemistry foresight study failed to devote a greater amount of attention to the (future) needs of industry, especially to those research themes that could generate new industrial activity and employment.

The committee fully subscribes to the recommendation to concentrate 75% of the chemistry research in the fields to which the Chemistry Foresight Committee refers. The current fragmentation in research must be fought against by clearly profiling each institution, establishing a higher number of alliances and achieving programme differentiation. One of the starting points to achieve this would be to intensify exchange between chemistry research and the adjoining faculties of biology, physics and chemistry. A role is set aside in this regard for the committee referred to in 'Physics' (B 01). This committee will look into the communal problems facing engineering and the natural sciences.

The Foresight Steering Committee was unable to find sufficient support to set up a National Chemistry Council. Nevertheless, it still feels it necessary for the parties concerned to search for other ways of improving strategic collaboration and profiling in (academic) chemistry research.

B 03

MATHEMATICS

BACKGROUND

Mathematics research in the Netherlands is generally of a high standard and is recognised as such internationally. However, the small scale of this research is a threat to this otherwise strong position.

This was the conclusion drawn by the Mathematics Foresight Committee early in 1992 in its report *Mathematics – Ordering a Complex World*. Several of the committee's recommendations have since been followed up. The Minister of Education, Culture and Science asked the Foresight Steering Committee to formulate its opinion with regard to the other recommendations, partly with a view to other foresight studies.

APPROACH

Having consulted the Royal Netherlands Academy of Arts and Sciences the Foresight Steering Committee had a background document drawn up in the form of three essays. The three perspectives taken were: applications for mathematics research in the social sciences and in the areas of finance and economics; applications in engineering and the natural sciences; and developments in mathematics itself. This background document was subsequently discussed at the conference 'Mathematics in the Netherlands' held in April 1996.

FINDINGS AND RECOMMENDATIONS

Grave concern was expressed in both the background document and at the conference as to the sharp drop in student intake figures, implying even greater pressure on the already moderate research budgets. A gap – some even referred to it as a difference in status – was also detected between applied and fundamental research. Interaction between mathematics research and (potential) users (also in other disciplines) must be intensified.

The current problems compel the further profiling and forming of networks between the individual mathematics faculties. More multidisciplinary collaboration is called for, partly with a view to the flow of mathematical knowledge to adjacent areas of research. Extending the duration of initial degree programmes from four to five years is considered desirable to achieve this. It was also suggested to set up a European Centre of Excellence in the Netherlands for stochastic research and operational research ('Eurandom').

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

Mathematics is an essential basic discipline in which research is currently being subjected to an amount of pressure even greater than that in physics and chemistry. The question is whether, in the current situation, this discipline is completely viable in all faculties.

The Foresight Steering Committee subscribes to the necessity for the far-reaching profiling of each university in this field in accordance with the strengths aimed for in adjacent disciplines. The committee also calls for a further concentration of research as well as more opportunities for multidisciplinary collaboration. Here too is a contribution expected from the committee referred to in 'Physics' (B 01), which is drawing up a coherent plan of action for engineering and the natural sciences. Meanwhile, funding based on student intake figures must not be allowed to result in research falling below the critical mass.

B 04

INFORMATICS

BACKGROUND

System and software orientated informatics research in the Netherlands has gone through a period of rapid development. At present there is talk of a certain consolidation and the need for new orientations. Consequently, in his 1995 Science Budget, the minister of Education, Culture and Science proposed a foresight study for this field.

APPROACH

At the Foresight Steering Committee's request, Prof.dr. J.C. Arnbak, professor of tele-information engineering at Delft University of Technology, wrote an essay on the current, and possibly future developments in information and communication technology (ICT) preparatory to the foresight study. This essay explains how ICT calls for utilisation of the exact and design-oriented engineering sciences as well as the arts subjects and social sciences. Subsequently, the Foresight Steering Committee, in conjunction with the Ministry of Education, Culture and Science and the Foundation for Informatics Research in the Netherlands, set up an Informatics Foresight Committee. At the preliminary conference to this foresight study in January 1996 the Foundation for Informatics Research in the Netherlands added a list of research subjects to that essay. The central question asked in the Informatics Foresight Committee's foresight study was: what functions will information systems fulfil in tomorrow's society, and which informatics research will be required for those systems?

FINDINGS AND RECOMMENDATIONS OF THE INFORMATICS FORESIGHT COMMITTEE

Certain scenarios for the future role of Dutch software companies played a significant role in the informatics foresight study. One aspect put forward in this study was that the position taken in by the Netherlands in research and development in the field of ICT will help determine the economic structure and level of prosperity. The development and application of advanced software contributes enormously towards the necessary increase in the knowledge intensity of Dutch products and services. Informatics research is the essential basis in this respect.

The Informatics Foresight Committee detects too strong a focus on theoretical research themes and too little attention to the conversion of research results into practical applications. When allocating the research budget to autonomous and strategic research, the accent should be on the latter over the next few years. The Informatics Foresight Committee calls for an 'agenda for strategic research', updated every two years, which could prevent fragmentation and should encourage work on socially-relevant themes. This agenda should be drawn up by a committee consisting of representatives of the scientific community, trade and industry and government. The existing research infrastructure is considered adequate for this; the establishment of new institutes should consequently be avoided. The Informatics Foresight Committee also calls for a higher level of multidisciplinarity, greater use of experimental research methods and a concentration of associated research and training courses in faculties.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The report of the Informatics Foresight Committee presents several useful research themes which could be given priority for stimulation over the next few years. This committee focused particularly on informatics and the software industry; according to the Foresight Steering Committee it would also be interesting to map out the links with the strong sectors of the Dutch economy as this would probably reveal niches for the Dutch software industry on the world market. The Foresight Steering Committee also feels that more attention must be given to the role played by informatics in understanding and resolving societal issues such as safety, the environment, energy and health.

Further intrinsic development in this field must be assured. Additionally, renewed attention is needed for the functional and organisational relations between informatics and adjacent disciplines, especially mathematics. The Foresight Steering Committee supports the proposal of drawing up a research agenda every two years. The strengths and weaknesses of current informatics research must be taken into account in the further elaboration of the research framework presented by the Informatics Foresight Committee, especially where that framework suggests a shift in focus. Generally speaking, the map of the research landscape will need to be expanded further in order to make effective and efficient steering of the programmes possible. A reduction of the current fragmentation, for instance by setting up research schools, is evidently of the utmost importance. Finally, a greater understanding must quickly be obtained into the future need for people practising informatics and into ways of guaranteeing a substantial increase in the number of students.

B 05

EARTH SCIENCES

BACKGROUND

A restructuring of the educational and research programmes in the eighties and nineties resulted in the different earth sciences being brought under one heading. Six 'research schools' were formed in this field. Belonging to the earth sciences are: soil science, physical geography, geochemistry, geodesy, geophysics, geohydrology, geology, geotechnical sciences, meteorology/climatology and oceanography. It was thought that an investigation into the future questions and problems in this field of research would be appropriate. As was the case in other foresight studies, here too was the long-term coordination of the supply of research and the needs for knowledge one of the main focal points. Also of importance for the earth sciences is the extent to which the current interest in research connected with 'Global Change' will take on a permanent character. An associated question is what this implies for research which has absolutely no connections with the 'Global Change' theme.

APPROACH

A preliminary document was drawn up at the beginning of 1995 by the Council for Earth Sciences of the Royal Netherlands Academy of Arts and Sciences. This document served as the point of departure for a preliminary conference in May 1995. Subsequently, the Royal Netherlands Academy of Arts and Sciences and the Foresight Steering Committee took the initiative to set up an Earth Sciences Foresight Committee which commenced its work in September 1995. This committee developed three scenarios for the identification of (new) research themes in a wider context, offering a variety of settings at different points in time in the year 2010. Whereas the three scenarios are all based on the same trend data, such as the growth in world population, they differ on three points:

- the care taken by man in connection with the finiteness of our natural resources;
- the extent to which economic growth may be at the earth's expense;
- the direction internationalisation will take (attitude, level of collaboration).

PROVISIONAL FINDINGS OF THE EARTH SCIENCES FORESIGHT COMMITTEE

When this overview was drawn up the Earth Sciences Foresight Committee had not yet completed its foresight study. However, it disclosed several provisional findings in its interim report (March 1996).

According to the Earth Sciences Foresight Committee it would seem as if there are no major problems in the field of earth sciences. A consolidation operation brought about a reduction in the number of faculties on the supply side of research over the past few years. The setting up of research schools, according to the committee, helps towards a more distinct demarcation of roles. This does not alter the fact, however, that it still might put forward some additional proposals for collaboration.

It is anticipated that the government will remain to be one of the main users of research in the field of the earth sciences. Research themes of relevance to policy include sustainability, protection against climatic and geophysical risks, and the tackling of continental and global environmental problems. There is a shift to be seen in trade and industry from the traditional users of knowledge (the oil companies) to businesses operating for instance in underground infrastructure or coastal and river management. In its final report the Earth Sciences Foresight Committee will also devote attention to the indirect role the earth sciences play in other sectors which also make a substantial contribution to the Dutch economy.

The committee also speaks of the importance it attaches to coordination and collaboration among research schools, as well as the coordination and collaboration between these centres of knowledge and the users of research. The Earth Sciences Foresight Committee indicates the following as major research themes in its interim report: utilisation and ‘physical planning’ of the substratum; the climate system; the functions of water; natural disasters which involve enormous risks for man; quantitative/model studies (e.g. into water systems, climate, reservoirs).

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

It would seem that the earth sciences foresight study followed the Foresight Steering Committee approach really well. The Foresight Steering Committee looks forward to reading the committee’s final report.

B 06

BIOLOGY

BACKGROUND

Various scientific disciplines display a growing interest in questions which originally were of a biological nature. This partly has to do with the successes booked in molecular biology. The discipline boundaries are also shifting within the bio-sciences. It is claimed that there are two sides to the biology of today: the ecological (there are many uncertainties in the life processes) and the chemical (the certainty of the DNA molecule).

The main challenge for the coming years is to integrate the knowledge gathered at the various levels, from molecule to eco-system, into new insights. This is necessary if we are to come to grips with the ever-increasing, predominantly multidisciplinary questions. The general view is that a foresight study in this field can help biology to focus on new strategic orientations.

APPROACH

A preliminary document was drawn up in the autumn of 1995 at the assignment of the Foresight Steering Committee and the Biology Council of the Royal Netherlands Academy of Arts and Sciences. This document[1] argues, among other things, for the reinforcement of the scientific and theoretical side of biology in order to be able to integrate the different sources of knowledge and promote the generation of multiple theories. The document was discussed in March 1996 at a preliminary conference of delegates representing the supply and the demand side of biological research. On that occasion agreement was overwhelming that a biology foresight study was needed and was indeed opportune.

This foresight study must serve both biological research itself, as well as the relation between that research and its environment. In other words, the main aspects in biology are the identification of priority research themes, the stimulation of system orientation, the integration of knowledge and insights at different levels, and the consequences of all of this for the study programmes and for the organisation of research. With regard to the outside world, the foresight study should be able to explain the significance of biological research for various sectors of society and for tackling important issues such as sustainability. Certain aspects will need to be studied from an international perspective, taking the developments in associated disciplines into account (trends shown in other foresight studies, for example).

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[1] *De biologie in de 21e eeuw* (Biology in the 21st Century).

The foregoing led the Foresight Steering Committee and the Biology Council of the Royal Netherlands Academy of Arts and Sciences to establish the Biology Foresight Committee. The results of the foresight activities of this committee are expected towards the end of 1996.

B 07

RESEARCH IN THE FIELD OF NATURE AND THE ENVIRONMENT

BACKGROUND

Foresight activities are carried out on a regular basis for research in the field of nature and the environment. The Advisory Council for Nature and the Environment, in which the research community and the user's side are represented, plays a central role in these activities. A great deal of environmental-relevant research is also carried out under different headings, such as chemistry, energy, production technology, agriculture and traffic and transport. The Foresight Steering Committee, together with the Advisory Council for Nature and the Environment, has checked the extent to which these associated fields yield conclusions for research in the field of nature and the environment in the strictest sense.

APPROACH

The Advisory Council for Nature and the Environment publishes a long-term perspective every four years on what are considered necessary developments in this field. The point of departure for this research plan is the strife towards sustainability, whereby economic, ecological, technological and societal aspects must be integrated.

In the 1996 Long-term Perspective attention is also devoted to the requirements for the knowledge infrastructure. In addition, the Foresight Steering Committee initiated a foresight study into the needs for environmental knowledge in the longer term and its implications for the study programmes and research. The most important conclusion is while the demand for environmental experts will remain more or less constant, there will be a greater need for specialists than for people with a more general training.

FINDINGS AND RECOMMENDATIONS OF THE ADVISORY COUNCIL FOR NATURE AND THE ENVIRONMENT

The Advisory Council for Nature and the Environment detects a reduction in the funds for authentic research in the field of nature and the environment. This reduction is partly the result of external integration of environmental aspects in a variety of policies pursued in the business world and by government, the increasing level of internationalisation and the growing emphasis on decentralisation and the execution-orientation of policy. There is a tendency to emphasise direct applications. This trend, fears the Advisory Council for Nature and the Environment, could be at the cost of that fundamental and strategic research in the field of nature and the environment which is the source of tomorrow's solution-oriented research.

The Council therefore sees good reason to strongly urge national government to continue stimulating strategic and interdisciplinary research focused on the long term. This should be done in the form of programmes which establish links between fundamental and more application-oriented research. Bringing the Dutch research effort and Dutch priorities into line with research elsewhere should play a role here.

The Advisory Council for Nature and the Environment makes mention of two comprehensive research themes which deserve particular attention over the next few years. Both are concerned with the necessity to investigate the ecological boundaries and risks and make them manageable. The first is 'the ecological restructuring of the economy'. This calls, among other things, for research into a more frugal use of raw and other materials and into the conservation of energy. The second theme is 'integral utilisation of space' for housing, infrastructure, agriculture and recreation. Options can be sought in the separation as well as the interweave of functions. The Council sees research priorities mainly in the field of ecological pre-conditions, technology and administrative and juridical issues.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The Foresight Steering Committee sees no reason to develop other foresight activities in addition to the Advisory Council for Nature and the Environment's Long-term Perspective, a document which is in line with its own procedures. The increasing amount of pressure on short-term solutions, which places fundamental and strategic research in the field of nature and the environment at a disadvantage, is also of major concern to the Foresight Steering Committee. It subscribes to the research themes recommended by the Advisory Council for Nature and the Environment for the long term.

B 08

AGRICULTURAL SCIENCES

BACKGROUND

The agricultural sciences are very important for the Netherlands; thanks to them, the Netherlands has achieved many international successes in the field of agriculture and horticulture. The agricultural sector must adjust to the changes taking place in its surroundings. Examples being the more effective market forces, the increasing administrative complexity and the changing attitudes towards nature, the environment and the use of animals.

The changing situation also has an effect on research questions. Major developments are also seen in those fields of knowledge and technology which are relevant to this sector. A foresight study into agricultural research was regarded as opportune on the basis of these aspects.

Foresight activities in the agricultural sector have been carried out for some time now by the Netherlands Council for Agricultural Research, a council in which both research institutions and their 'clients' work together. This council develops long-term research programmes (Long-term Perspectives) and supervises their implementation. The Foresight Steering Committee therefore collaborated with the Netherlands Council for Agricultural Research for this field of research and for the further development of its methodology.

APPROACH

Towards the close of 1993 the Foresight Steering Committee and the Netherlands Council for Agricultural Research jointly organised a scenario workshop in which three scenarios were developed for the agricultural research environment in the year 2015. These three scenarios were based on the themes 'market', 'the environment' and 'consensus'. The scenario results were worked out by the Netherlands Council for Agricultural Research in its Long-term Prospective 1995-1998. Three comprehensive research themes were proposed partly on the basis of this scenario analysis. These themes, intended to achieve a (re)orientation of agricultural research over the next few years, are:

- the development and use of rural areas;
- development of competitive, sustainable agricultural systems;
- administrative problems.

SUPPLEMENTARY FORESIGHT STUDY INTO TRAINING AND EDUCATION

To supplement the existing foresight activities the Minister of Agriculture and Fisheries requested the Foresight Steering Committee and the Netherlands Council for Agricultural Research to jointly carry out a foresight study into the university component of the knowledge infrastructure for the agricultural sector. This foresight study focuses on the year 2010. The point of departure is the need for knowledge to serve trades and industries in the agricultural sector and making the best possible use of the existing 'green zones' in the country. This has implications for study programmes and research in general and for Wageningen Agricultural University in particular.

Developments in the field of action (agribusiness and food, green areas) indicate that the object of agricultural sciences will continue to expand. This is leading to problems which can only be approached by making additional mono-disciplinary and interdisciplinary efforts. Developments in science and technology have also resulted in a less sharp line between the different agricultural sciences. Changed administrative and market conditions (student intake, funding, internationalisation), lead to a strongly increasing level of competition among the institutes of knowledge. The Foresight Committee feels that the current profile of the Wageningen Agricultural University is not yet ready to deal with these changes. According to the committee, the Agricultural University will have the best prospects if it chooses to adopt a leading role in the (inter)national dimension as the integrator of knowledge in its field, both in education and in research. This would call for an additional choice to be made in connection with its core competencies (high quality, sufficient critical mass) in combination with entering into strategic alliances with other institutes of knowledge.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The Foresight Steering Committee subscribes to the foresight committee's conclusion that Wageningen Agricultural University will not be able to continue to offer the whole range of high level education and research. Choices will need to be made and the University will need to look for partners. The foresight report sets out the attractiveness, the conditions and the risks of three options. This makes it an inspiring document that can act as a catalyst in the discussion, both for Wageningen Agricultural University itself as well as for the Ministry of Agriculture.

B 09

ENERGY RESEARCH

BACKGROUND

In 1993 the Ministry of Education and Science (as it was then) considered setting up a national platform for energy research with a focus on the long term. At the time there was doubt as to whether energy research conducted in universities was sufficiently geared towards future issues connected with the strife towards sustainability. A steering group, established specifically for this purpose, attended one of these platforms early in 1994 armed with a preliminary foresight study. Subsequently, the Foresight Steering Committee and that steering group drew up a preliminary document for a potential foresight study. It was then concluded at a conference, at which both documents were discussed, that a further foresight study into energy research would be appropriate for the longer term (10 to 25 years). An Energy Research Foresight Committee was then set up under the auspices of the Foresight Steering Committee.

APPROACH

The Foresight Steering Committee observes that there are many good scenario studies in the field of energy available. This was reason for the decision that further analysis of a selection of these studies would suffice. Included among those factors of significance to the energy environment in this analysis are energy prices, growth in world population, economic growth, government policy on the environment and guarantee of deliveries, and the independent speed of efficiency improvements. 'Sustainability', as used in the scenarios and policy studies that were analysed, was taken as a principle for steering the Dutch energy supply.

Research policy wishing to support a more sustainable energy supply, says the Foresight Steering Committee, may not lean too much on extrapolations from the past. On the other hand, the objection made to some normative scenarios was that they failed to take account of the connection between technological potential and daily practice. Using an overview of Dutch energy research as the basis the committee wished to establish the extent to which current knowledge fails to provide answers to the main questions for the longer term.

FINDINGS AND RECOMMENDATIONS OF THE FORESIGHT STEERING COMMITTEE

On the basis of the scenarios the Foresight Steering Committee does not expect an absolute scarcity of fossil fuels to arise within the next 50 years, consequently, it anticipates no substantial price increases. On the other hand, the committee does feel that the development of affordable and clean energy will largely determine the course to be taken with regard to global environmental problems. The Energy Research Foresight Committee makes the following recommendations in its final report:[1]

- Given that our nation will be more or less dependent on a sustainable energy supply in 50 years' time, we must, even at this stage, bring our energy research more into line with those areas of technology which make it possible to progress towards a sustainable energy supply.

- All the different directions in energy research (including nuclear energy research) must be involved in an integral process of deliberation on the basis of the aim to achieve sustainability. The criteria for setting priorities are the possibilities for application in the Netherlands and the export potential for Dutch trade and industry, including exports to the developing countries.

- The biggest contribution towards sustainability can be made by improving efficiency when using energy and materials. Research and development focusing on the long term should make a substantial 80 to 90% saving possible in the year 2050.

- A great deal of effort must be put into developing renewable sources of energy, particularly solar, wind and biomass. Emphasis in research must be on reducing the cost price of sustainable energy technologies and integrating new sources into the existing practice in the supply of energy.

Among the remaining points to be given attention in research policy in this field are: international coordination, intensification of the cohesion in research at national level, and the promotion of system analyses prior to the introduction of new technology. Last of all, the Energy Research Foresight Committee calls for an Energy Research Platform to be set up as a team effort of research organisations and users and financiers of research. The tasks of this platform would be to assess the national research portfolio and to enlighten research priorities, or in this case, the political options. Consensus was reached on the main lines of the Energy Research Foresight Committee's final report at a conference held early in 1996.

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[1] *Verkenning Energieonderzoek – Zoektocht naar richting in een doolhof* (Energy research foresight study – The pursuit to find one's bearings in a labyrinth).

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The Energy Research Foresight Committee report presents a sound analysis of the demand side of long-term research in relation to the strife towards sustainability. The necessity to operationalise this concept forces the suppliers of research to change their orientation. Collaboration, national and international and between researchers in the fields of science and the social sciences, is becoming more and more important. According to the Foresight Steering Committee, the apparent consensus on the orientation towards sustainability in terms of content marks a U-turn in the way of thinking about the energy supply and the research policy in this field.

Another factor alongside 'sustainability' is the liberalisation of the energy markets in Europe. This brings about a change in the relations between the production and the distribution of energy. The European Union is playing an increasingly significant role in European energy research. The Energy Research Foresight Committee has not voiced an opinion with regard to the division of tasks in this field; this is an aspect which deserves attention. Further analysis is also required with regard to the subject of the consequences of the foresight results for concrete policy on energy research in universities.

B 10

MICROSYSTEM TECHNOLOGY

BACKGROUND AND APPROACH

Various foresight activities, such as the portfolio analysis of engineering and the natural sciences (B 17), indicate an increasing interest in microsystem technology (MST). Microsystem technology is a generic term for all technologies needed to manufacture products and components smaller than a few millimetres. In the spring of 1995 the Foresight Steering Committee held a conference on the prospects both for and with MST. This led to a consultant being commissioned to carry out a foresight study into the opportunities and obstacles regarding microsystem technology in the Dutch knowledge infrastructure. The study itself was based on interviews with a large number of experts in the field and supported by a study of the literature. Potential options for MST were investigated, as also were the markets for MST. The policies pursued in this field in neighbouring countries were also looked at. Potential problems standing in the way of further development were also mapped out and options put forward for their removal.

FINDINGS AND RECOMMENDATIONS OF THE 'MICROSYSTEM TECHNOLOGY' REPORT

One of the conclusions of this report is that the Netherlands is among the top five European countries in the field of microsystem research. It is expected that the market for products in which these systems play a role will undergo rapid growth over the next few years. However, one problem facing the further development of microsystem technology is that Dutch trade and industry is somewhat slow to take up research results. The report suggests the following possibilities to improve this:

- Strengthening the intermediate function so as to bridge the gap between universities and trade and industry, coupled with good coordination of the demand for knowledge.
- Bringing the level of technology more into line with the needs of the target group 'firms', and thus making it appropriate for use with the technologies already in use in firms, as well as bringing it into line with the knowledge already available in that particular sector.
- Government financial incentives for new MST applications.
- Widening and improving the standard of the study programme, particularly at higher professional education level.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

Both the study and the discussion about the study confirmed the views of the Foresight Steering Committee that microsystem technology is of strategic importance for Dutch trade and industry. The problems facing further development are not so much in the research itself but in the application thereof. Options to influence these problems are consequently to be found mainly within the sphere of the Ministry of Economic Affairs. The report gives a good initial impetus for the universities and trade and industry to strengthen the research-development-application chain.

B 11

NANOTECHNOLOGY

BACKGROUND AND APPROACH

Nanotechnology is a generic term for research and development within a large number of disciplines, the common characteristic being that the research is on a scale of a few to several dozens of nanometres. This generic term includes important fundamental research themes which are extremely challenging in the scientific sense and (can be) of great societal significance. The Foresight Steering Committee commissioned a foresight study to be carried out by a consultant into the development of nanotechnology in the Netherlands. This was partly in response to foreign foresight studies and partly on the basis of the engineering and the natural sciences' portfolio analysis (see B 17). The objective was to gain insight into research in the field of nanotechnology in the Netherlands. It was a study which was also for the purpose of pointing out the application possibilities and options for research policy in this field.

FINDINGS AND RECOMMENDATIONS OF THE 'NANOTECHNOLOGY' REPORT

In the Netherlands it is mainly fundamental scientific research which is currently being conducted in the field of nanotechnology (occasionally referred to as 'nanoscience'). This research is held in high esteem throughout the whole of Europe; the Netherlands has even attained an excellent position for itself in certain disciplines. It is expected of these fields of research that they will have a major influence on the development of large industrial sectors such as microelectronics, the chemical industry and the pharmaceuticals industry over the next decade or two. The study concludes that nanotechnology could, in due course, become eligible for programmed stimulation via the Netherlands Organization for Scientific Research, TNO or a so-called Innovation-Oriented Research Programme. Another option is project stimulation in the European dimension. First and foremost, we must obtain a greater understanding of the international efforts in this field, and the interdisciplinary themes will also need to be inventoried. A clear demarcation of this new field of research could boost its development.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

Nanotechnology is a fascinating field of research. Its implementation in the Netherlands still has a mono-disciplinary character. The Foresight Steering Committee therefore recommended that this field should be stimulated particularly on the basis of interdisciplinary themes of research related to applications which are of interest to the Netherlands. The Netherlands Organization for Scientific Research is the most appropriate body to do this.

B 12

TRAFFIC, TRANSPORT AND THE INFRASTRUCTURE

BACKGROUND AND APPROACH

Even before the inauguration of the Foresight Steering Committee in 1992 had the Science and Technology Advisory Council recommended that the subject of 'traffic and transport' be placed on the foresight agenda. In mid-1992 the Foresight Steering Committee organised a round-table conference on this subject. It was at this conference that a coherent approach focusing on the more fundamental and long-term issues was argued for with regard to research in this field.

The Minister of Transport and Public Works had already established a Steering Committee for the Traffic, Transport and Infrastructure Research Programme. This steering committee held a scenario workshop in collaboration with the Foresight Steering Committee in the spring of 1994 at which the following strategic research themes were generated: developments in individual mobility; collective passenger transport; logistic chains; intermodal transport. Programme advisory committees were set up for each of these themes consisting of representatives of the ministries, trade and industry and the research community.

The Steering Committee for the Traffic, Transport and Infrastructure Research Programme presented the separate programmes and its conclusions in the report entitled *Development of Knowledge in Traffic, Transport and Infrastructure* (June 1996). The steering committee noted that there was a lack of attention on the demand side for general development of knowledge and for dependable strategic research. Quickly applicable results are called for, both by the business world and by government. A generally accepted societal vision regarding traffic, transport and the infrastructure is lacking. The steering committee wishes to achieve a higher level of cohesion by way of periodic programming. The proposed research programme will cost Dfl. 70 million.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

Research in the field of traffic, transport and infrastructure is immensely important for the Dutch economy. Nevertheless, it is impeded by the lack of integral structures on both the supply and the demand side. The Foresight Steering Committee notes that the Traffic, Transport and Infrastructure Steering

Committee has intensified the forming of concepts, the formulation of questions and has boosted communication between the supply and demand sides of this wide and significant field.

The research themes chosen by the steering committee fit perfectly in with the Foresight Steering Committee's themes. Within the framework of the integral use of space the Foresight Steering Committee is of the opinion that research should focus on the further development of transport systems as well as on insights into the use, the dynamics and the management of such systems and also on technological solutions to transport problems. Speed is of the essence where starting up a process geared towards future problems is concerned; a process calling for breakthroughs in both vision and in technology.

The Foresight Steering Committee requests that attention be given to the suggestion of working towards a multidisciplinary centre for traffic and transport studies over the next few years, a centre in which trade and industry would also participate. It feels that stimulating the augmentation of knowledge in this field in the long term (the relation between education and research being the main link) is of paramount importance. Further study is necessary in the short term to increase the level of understanding into the qualitative and quantitative developments in education.

B 13

AVIATION TECHNOLOGY AND AEROSPACE TECHNOLOGY

BACKGROUND AND APPROACH

The situation in Dutch aviation technology and aerospace technology was also looked at in the previously mentioned portfolio analysis of engineering and the natural sciences (see B 17). Dutch research in this area of activity has an excellent reputation in several fields. The government funds a relatively large part of the research carried out in this sector. One problem facing the future of Dutch research in the field of aviation technology and aerospace technology would seem to be the utilisation of the knowledge infrastructure in this field for other significant economic activities. This was the reason for investigating the possibilities for strategic reorientation in these fields. To this end, the Foresight Steering Committee commissioned the Netherlands Organization for Applied Scientific Research to draw up preliminary documents for both aviation technology and aerospace technology. These documents were used as the basis for preliminary conferences with representatives of both the supply and demand side in these areas of research.

INITIAL STEPS FOR FURTHER FORESIGHT ACTIVITIES

Aviation technology in the Netherlands is going through a turbulent phase because of the current problems at Fokker. The preliminary conferences felt it urgently important that a foresight study should be conducted in this area of technology. A limited foresight study for aerospace technology was also supported, although this was considered less urgent. The idea was to carry out individual foresight studies in such a way that it would still be possible to establish clear, specific links between the two.

As far as aerospace technology is concerned, the advice was to develop a strong cluster in the field of earth-oriented space research, whereby use could be made of the results of the foresight study for the earth sciences.

Other aspects established at this conference that require special attention, as well as those ascertained in the preliminary documents, were:

- the relation between the level and extent of education and research and the (potential) use thereof;

- the future role of government-supported research programmes;
- the position of the National Aerospace Laboratory.

When drawing up this text, the discussions as to how the two planned foresight studies should be done were still under way.

B 14

PRODUCTION TECHNOLOGY

BACKGROUND AND APPROACH

'Production technology' as a subject for foresight study was put forward by the Science and Technology Advisory Council for the Foresight Steering Committee's agenda. This field of knowledge is very important for the further development of Dutch industry. According to the Science and Technology Advisory Council the structure of the development of knowledge and the transfer of knowledge to users should be given more attention.

Early in 1994 the Foresight Steering Committee commissioned a preliminary document to be drawn up on this subject. That document was subsequently used as the basis for a round-table conference. Shortly before that the Ministry of Economic Affairs had started up a technology foresight study into production technology. Other initiatives had also been taken in this field. To prevent duplication, the Foresight Steering Committee decided not to undertake any foresight activities in this area.

FORESIGHT STEERING COMMITTEE COMMENTS

One major problem that became evident at the round-table conference was the vagueness regarding the demand for research in the field of production technology, especially from smaller businesses. A somewhat structured inventory of the demand for groups of similar businesses could help in this respect; any resulting research themes could then be raised with universities and research institutes by existing intermediaries.

A conference on microelectronics (organised by the Foresight Steering Committee) urged that programming questions should be tackled, especially those from the demand side. The main client for knowledge in the field of production technology and microelectronics is the manufacturing industry. The Foresight Steering Committee feels that the knowledge needs of this substantial sector of industry for the longer term deserves further investigation.

B 15

SERVICES

BACKGROUND

The workforce in the Dutch service sector currently stands at almost 70% of the total Dutch working population. Knowledge intensity and innovation are prerequisites to be able to compete in the international dimension. The (future) demand for knowledge by, and the supply of research for this sector is rather obscure. Foresight activities focusing on this area would therefore seem essential.

APPROACH

Commissioned by the Foresight Steering Committee, the TNO Centre for Technology and Policy Studies produced a preliminary study early in 1995.[1] The enormous diversity in this sector makes it difficult to explore the wide demand for knowledge in this field. First of all a specification and inventory was drawn up of all the aspects concealed in the somewhat diffuse concept of 'services'. The main players in the different segments of this sector were mapped out (on both the supply and the demand side), and an outline was drawn up of the most significant trends and associated demands for knowledge. Potential consequences of more general trends, such as the interweave between industry and services, specialisation and integration, intensification of knowledge and internationalisation, were all looked into for the service sector as a whole.

FINDINGS OF THE PRELIMINARY STUDY

The researchers observed a discrepancy between the well-promising opportunities and the future importance of information and communication services on the one hand and the fragmentation of the relevant Dutch knowledge infrastructure on the other. They made a recommendation to start up a foresight study in this field. Aspects such as the integration of knowledge, the management and the development of knowledge, offer good points of departure.

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[1] *Kennis voor de dienstensector* (Knowledge for the service sector).

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The preliminary study presents a clear picture of the problems facing the development of knowledge for the Dutch service sector. This study was partly the reason for the Foresight Steering Committee to commission essays on information and communication technology and on communication. These papers were then used in the informatics foresight study. The wide range of knowledge, of importance for the service sector, will obviously be taken into consideration in other foresight studies: mathematics; traffic, transport and the infrastructure, and the humanities, for instance.

The Foresight Steering Committee is of the opinion that potential knowledge opportunities for the service sector should be included more explicitly in future foresight studies. It will also be necessary to formulate the demands for knowledge in this field more accurately. To this end, the aim should be towards conducting foresight studies for each segment of the service sector in collaboration with the trade and industrial organisations.

B 16

DEFENCE RESEARCH

BACKGROUND

Dutch defence research focuses on the development and deployment of an armed force which suffices as an instrument in the security policy of both government and parliament. This is the main goal of Dutch defence policy. The change in international relations over the past few years has caused the security situation to change drastically too, leading to a review of Dutch security policy and a reduction in the defence budget.

The emphasis in Dutch security policy now comes to lie on keeping the risks in check that emerge from *inter*state and *intra*state conflicts in countries bordering on NATO territories or countries outside Europe. The Netherlands wishes to contribute towards the prevention and control of such conflicts. Another point requiring attention is the concern about the increasing proliferation of arms and arms technology (including chemical, biological and nuclear).

The current main tasks of the Dutch army, which recently became a voluntary army, can be summarised as follows:

- performing crisis control operations;
- protecting the integrity of its own territory as well as that of allied nations.

Defence research plays a very important role in developing an understanding of the structure, the composition and the deployment of this new armed force. The role of knowledge and technology is shifting; in the past, technology was seen mainly as a force multiplier in defending against a numerically stronger and known enemy. It has now become a means of developing sufficient dominance in often extremely complicated situations with only limited numbers in order to be able to execute peace operations. Information, preferably in real time, is of crucial importance here. The field of knowledge will widen to include conceptual design, issues regarding personnel (both medical and socio-scientific) and economic issues.

APPROACH

In consultation with the Ministry of Defence, the Foresight Steering Committee is now investigating whether there is sufficient support for a broad foresight study of the long-term needs for research in the field of defence. A preliminary document will be drawn up and should be available at the end of 1996.

B 17

ENGINEERING AND THE NATURAL SCIENCES PORTFOLIO

BACKGROUND AND APPROACH

The Foresight Steering Committee's Engineering and Natural Sciences study group felt the need for further argumentation with regard to the choice of fields of research for foresight studies. An assignment given to the TNO Centre for Technology and Policy Studies to look into that need resulted in two studies. The first was a report which has been mentioned several times already.[1] On the basis of a study of the literature, including foreign Delphi studies, this report identified and looked into those technologies and disciplines which are of strategic importance for the Netherlands in engineering and the natural sciences.

The second looked at the various (policy) arguments put forward for investing in this field of knowledge.[2] This report warns of considerable tension between the generally stressed significance of this broad sector of research – in the economic, social and scientific sense – and the drastic fall in number of students and graduates in the disciplines in question.

CONCLUSIONS AND RECOMMENDATIONS FROM THE PORTFOLIO ANALYSIS

The study *The Dutch knowledge portfolio...* etc. identifies as the main demands for knowledge: environment-oriented product development and production processes; communication and mobility; sustainable food and agriculture; high-tech services; networks between the knowledge infrastructure and clients. In all fields, report the researchers, there is an increasing need to combine knowledge with technologies. Other conclusions and recommendations made in this study include:

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[1] *De Nederlandse kennisportfolio op het gebied van de technische en natuurwetenschappen en de belangrijkste technologiegebieden* (The Dutch knowledge portfolio in the field of engineering and the natural sciences and the main fields of technology).

[2] *Het belang van de technische en natuurwetenschappen* (The importance of engineering and the natural sciences).

- the most strategic areas of technology for the Netherlands are: production technology (current position: weak), material technology (reasonable) and information and communication technology (reasonable);
- transport technology, energy technology, computational modelling, environment technology and electronics are of reasonable strategic importance;
- the conditions for improving the workings of the knowledge market are: better articulation of the demand by trade and industry, and a stronger profiling of the knowledge infrastructure;
- a more effective chain approach is called for in science and technology policy;
- various opportunities for gaining access to technological knowledge must be looked at more critically: research, alliance-forming and 'purchasing'.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The conclusions drawn in the portfolio analysis contributed effectively towards the programme of the working group Engineering and Natural Sciences of the Foresight Steering Committee. Among the concrete follow-up activities were: the earth sciences foresight study; background studies for microsystem technology, nanotechnology and information and communication technology; the preliminary documents for aviation technology and aerospace technology. A public version of this portfolio study is being prepared.

B 18

TECHNOLOGY MAP FOR DUTCH BUSINESS

BACKGROUND AND APPROACH

The Netherlands' biggest employers association, the Federation of Netherlands Industry – Netherlands Federation of Christian Employers, came into action with the Ministry of Economic Affairs to improve how the demands of trade and industry for technological research are formulated. The plan of approach involves three separate phases:

1. Drawing up an inventory of those areas of technology which are or could become of importance for trade and industry, specified for each branch of industry in relation to the existing R&D efforts.
2. Structuring the exchange of information among businesses themselves, and between the business community and the knowledge institutions, in two steps: distinct formulation of the needs and detection of the bottlenecks in knowledge transfer.
3. Discussion between government, the knowledge infrastructure and businesses about the relation between government funding of the knowledge infrastructure and the contracting out of R&D by companies.

The Foresight Steering Committee participated in the first (now completed) phase, executed by Arthur D. Little consultants.

FINDINGS OF PHASE 1

The report on phase 1 sees the drop in investments in R&D in the Netherlands as the main problem.[1] Other conclusions of this report:

- competitiveness of the Netherlands in terms of technology has started to lag behind significantly;
- there are no 'top technologies'; Dutch business is investing stably in a broad technology portfolio;
- the five most R&D-intensive segments in the business community invest two thirds of the total of industrial R&D;

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[1] *A Technology Map for Dutch Business.*

- with a view to competition, Dutch trade and industry feels that interaction with the knowledge infrastructure needs to be intensified.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

Drawing up the *Technology Map* has given technology a higher place on trade and industry's agenda. After the first step, which concerned the current R&D effort of Dutch trade and industry, the long-term needs for knowledge in an international comparative perspective will need to be looked into in the next phase. This will need to include non-technical knowledge (organisation, financing, strategy, human resources, etc.).

The Foresight Steering Committee is of the opinion that the organisational involvement of Dutch business in the follow-up to the foresight process could have significant added value. Nevertheless, it should be pointed out that the mission of the public knowledge infrastructure reaches much further than the supply of knowledge relevant to businesses. Entrepreneurs must also realise that developing a new line of research is not done in a matter of days.

B 19

HEALTH RESEARCH

BACKGROUND

The Dutch health service is a substantial and complex social sector, swallowing up about 10% of the Dutch gross national product; some 2% of this amount goes into research. Scientific progress creates new possibilities for prevention, treatment and care. On the other hand, research based on societal developments can also increase the effectiveness and efficacy of the health service. The rapid development of medical technology generates ethical dilemmas and raises questions as to the cost and quality of care. Certain aspects call for considerable attention to be focused on bringing the future supply and demand in the field of health research into line. Foresight activities can make a significant contribution in this respect.

APPROACH

Foresight activities are more the rule than the exception with regard to comprehensive research in this sector. For instance, the Health Research Council publishes its *Long-term Perspectives* periodically; the next will be published in early in 1997. Consequently, the Foresight Steering Committee sought contact with existing activities and the major parties operating in this field.

To set out the demand side of this research the Health Research Council and the Foresight Steering Committee jointly formed a working group to prepare for a strategic conference which was held in the spring of 1996. To obtain an overview of the supply side, use was made of the report drawn up by Royal Netherlands Academy of Arts and Sciences.[1]

Potential future trends in the societal environment of health research were brought into view by using two scenarios for the long-term future. In the one, the accent was on the collective responsibilities, a considerable role being attributed to government; the other emphasised individuality and market forces.

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[1] *Discipline-advies Geneeskunde 1994* (Disciplinary Advice on Health 1994).

FINDINGS OF THE HEALTH RESEARCH COUNCIL AND THE FORESIGHT STEERING COMMITTEE WORKING GROUP

The working group set up by the Health Research Council and the Foresight Steering Committee investigated which health research would need to be stimulated over the next few years by adopting an extensive procedure which took into account the anticipated trends plus the current relation between supply and demand. Some 150 experts working in research and the practical field were consulted to this end.

Approximately 50 research themes were finally selected from the 200 proposals. Discussion of these themes at a strategic conference brought about very few changes in priority, something which the working group felt indicated wide support for the choices that had been made. The research themes put forward for stimulation were subsequently placed under five headings:

- chronic or chronically recurrent diseases;
- geriatric complaints and limitations inherent in the elderly;
- primary and secondary prophylaxis
- promoting independence and the ability to cope;
- the quality and efficacy of care.

ADDITIONAL COMMENTS OF THE FORESIGHT STEERING COMMITTEE

The available foresight study material brings the Foresight Steering Committee to several conclusions. With regard to training and education it observes several specific problems; hence the following recommendations:

- to make the medicine curriculum more scientifically-based;
- to give lecturers in medicine the opportunity to carry out fundamental research;
- to improve the career perspectives for junior researchers vis-à-vis those working in patient care professions.

With regard to the development of new medical technology, the Foresight Steering Committee calls for an evaluation to be made in good time as to the effectiveness of (new) diagnostic methods. The dynamism of any technology is difficult to influence in the final stages. It is for this reason that the government should take responsibilities upon itself at an earlier stage in the development trajectory, also in the financial sense. This applies with regard to development medicine and the development of new drugs for instance. Problems related to the ageing population call for better cooperation in the field of biomedical technology between the technical and the medical faculties. The development of technologies for use in the home, focusing on elderly, handicapped persons, should certainly be encouraged.

The Foresight Steering Committee also feels that the industry could use Dutch pharmaceutical expertise more effectively. Should existing pharmaceutical firms continue to lag behind in this respect, then the committee recommends the stimulation of new industrial activity. The New Drug Research Foundation, recently established by the Ministry of Economic Affairs, will be able to contribute towards improved utilisation of the knowledge available in this field.

Finally, the report of the Chemistry Foresight Committee points out that molecular life sciences are becoming more significant with regard to questions concerning health and ill-health. These disciplines should, in a multidisciplinary context, contribute more towards health research.

B 20

LABOUR, HEALTH AND SOCIAL SECURITY

BACKGROUND

The Netherlands has a relatively high level of sick leave and incapacity for work. Cost control in the Dutch health service and our system of social security is high on the political agenda. Research that can help raise the quality of life and employment, and thus reduce the number of people becoming incapacitated for work, is consequently also getting more and more attention. Nevertheless, research in the field of labour, health and social security is widely recognised as lacking in line and coordination. It is fragmented and there is no multidisciplinary infrastructure, an essential element for this field of research. Interaction between the field of research and the users in the relevant care sector could be improved. Consequently, sufficient reason for foresight activities in this field.

APPROACH

In collaboration with the Committee for Research into Health at Work, the Foresight Steering Committee organised a strategic conference in the spring of 1994. At this conference researchers and the users of research in this field discussed the problems and possibilities in this field of research based on a study drawn up by the Committee for Research into Health at Work. The Foresight Steering Committee also commissioned a study into the macroeconomic effects of preventive measures in the field of labour, health and social security.

The Health Research Council also carries out foresight activities in the field of research in the field of labour, health and social security. For example, the spring of 1996 saw the completion of a programming study commissioned by the Health Research Council which took the first step towards a cohesive research policy and the establishment of long-term priorities in this field.

FINDINGS AND RECOMMENDATIONS THAT ENSUED FROM THE FORESIGHT ACTIVITIES

From the macroeconomic analysis we see that the connections between labour, health and social security have not generally been subjected to any intense study at all. The Foresight Steering Committee urges the government to stimulate quantitative macroeconomic research in particular in this field.

The programming study referred to above attaches a great deal of importance to research focusing on design, implementation and the evaluation of measures. Subjects related to aspects of stress and well-being at work are given a higher priority than research into locomotive or safety aspects, for instance. Widening this research to include those subjects outlined in this study sets new demands on researcher training. The government, says the Health Research Council, has an important task to fulfil with regard to the strategic and fundamental research in the field of labour, health and social security.

The strategic conference attended by researchers and users stressed the necessity for a national platform to coordinate research in the field of labour, health and social security. This platform would specifically be called upon to contribute towards proper knowledge transfer and translation of the research results into solutions. Developments calling for particular attention are the ageing population, the multicultural composition of the working population and the strife towards the re-employment of those who are (partially) incapacitated for work.

Other recommendations that ensued from the strategic conference were:

- that researchers should devote more attention to instrument development, implementation and evaluation; in some cases this could lead to a shorter research time horizon;
- that the required disciplinary training basis (for researchers and other graduates) should be coupled to a high level of disciplinary integration in order to benefit care in this field.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

With a view to the societal trends in the field of labour, health and social security, the Foresight Steering Committee feels it essential that the government, or in this particular case the Ministry of Social Affairs and Employment, should assume responsibility for the problems. The essential structural reinforcement can for the time being be achieved on the basis of the current situation. In order to bring continuity into the pursuit of the various functions, the Foresight Steering Committee suggests the following:

- Reinforcement of demand-oriented programming and establishment of priorities could be assigned to the Health Research Council.
- Bringing the care sector and research in this area more into line could be promoted by the recently established *Zorgonderzoek Nederland* (ZON),[1] where necessary in conjunction with the Netherlands Organization for Scientific Research.
- Coordination and the quality of the research could be guaranteed in a research school (possibly newly established) in which the most eminent university and non-university institutions could collaborate.
- Such a research school should also act as the national and international contact office.

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[1] *Zorgonderzoek Nederland* (ZON), Dutch Care Research, a new organisation established by the Minister of Health. This organisation is in charge of programming and financing research and development for health care.

B 21

LAW

BACKGROUND

A trend has developed in our society to take legal action. The social functioning of law and jurisdiction is subject to change. Changed (international) balances of power, technological innovation, environmental issues, are all part of the developments taking place, developments which pose new questions for jurisprudence. What are the limits of this trend to take legal action? How can any constitutional state live up to its claims of freedom and equality before the law for its citizens in a complex society? Questions like these lead to new strategic orientations in juridical research. The relationship with other social and behavioural sciences consequently becomes more intense. The juridical field of research in the Netherlands wished to form a picture of these developments by carrying out a foresight study.

APPROACH

A strategic conference, at which both the supply and demand sides of juridical research were represented, was held early in 1995 in response to the preliminary document.[1] Subsequently, the Juridical Foresight Committee set out the potential future trends in the law and jurisprudence environment on the basis of three scenarios. The Juridical Foresight Committee took the differences in the level and nature of regulation as the core of these scenarios.

The first scenario searched for a balance between constitutional state values and the economic train of thought. Regulation in this scenario is a combination of public and private law, mainly determined by the European legislators. Regulation in the second scenario is largely concerned with public law, determined nationally. The third scenario focuses on economic effectiveness: the Netherlands attempts to hold its own ground at the global level; private law dominates the legal system.

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[1] *Hoe zal het recht zijn loop hebben?* (What will be the future course of justice?).

CONCLUSIONS AND RECOMMENDATIONS OF THE LAW FORESIGHT COMMITTEE

The Law Foresight Committee presented its final report in the autumn of 1995.[2] By putting forward recommendations, the committee wished to increase the contribution made by juridical research in answering the questions asked by society. Law, says the Law Foresight Committee, not only serves and follows, but is manifesting itself more and more as an autonomous discipline. Its powers of assertion are by no means a matter of course; a broadly-based intellectual research effort will need to be made in order to maintain, or make, the principles of law in our modern society. To this end, the international and comparative component of research will first need to be reinforced. Also, it is important to tighten the bonds with the social and the behavioural sciences. A broader training for junior researchers, honouring research proposals submitted by more than one department, an exchange of university chairs, and a rotation of lecturers are among the possibilities for collaboration.

According to the Law Foresight Committee too little attention is given to two themes which are crucially important to maintain a strong legal system in the next century. The first of these is decision-making in a multiform society. The committee feels that the tension between the fragmentation of existing links, and the continuing necessity of binding decision-making, is an enormous challenge for juridical research. Vital concepts for law, such as unity of law and equality before the law, come to stand in a different light because of that fragmentation, both at macro level and the level of the individual.

The second subject which the Law Foresight Committee feels should be given more attention is the deterioration of standard juridical categories. Traditional concepts, such as 'citizen' and 'spouse', need redefining. Basic concepts like ownership, contract and liability must also be amended for them to comply with our changing society. Because these changes are so fundamental, juridical research should not avoid questions as to the foundations and persuasiveness of the juridical discipline.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The Foresight Steering Committee regards the final report of the Law Foresight Committee as a perfect example of the kind of foresight study the Foresight Steering Committee has in mind. It is an inspiring document which gives an insight into both the supply and the demand side of juridical research. This foresight study helps research to become geared towards those questions that will face the Dutch constitutional state and juridical developments in the coming years. The Foresight Steering Committee subscribes to the conclusions drawn by the Law Foresight Committee and is in full agreement with the recommendations it put forward.

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[2] *Een eigen richting voor het recht...* (A specific direction for law...).

For very good reasons this field of research is asked to give attention to the manner in which juridical research can contribute towards how societal issues are approached. Of importance in this connection is the recommendation to give priority in postdoc policy to those researchers wishing to investigate the boundaries of their own field of law. Also, and quite rightly so, is emphasis given to those questions connected with internationalisation of the national legal system.

In its report, the Law Foresight Committee also looks at foreign initiatives taken to update and structure juridical research. This is done by striving towards collaboration within larger units and by stimulating international contacts (e.g. the Academy of European Law, Florence and Elite Law Schools in the United States). The Foresight Steering Committee supports the idea of the Netherlands joining in on such initiatives. One or two excellent research schools could provide an incentive for innovating the juridical climate by way of pioneering research. Serious consideration should be given to government support of such initiatives.

B 22

ECONOMICS

BACKGROUND

Signals indicating the need for foresight study for economics came from both the research field and from the users. There is a great deal of applied economics research done in the Netherlands to benefit, among other things, (government) policy in several fields. It is assumed that the relation with the more fundamental and strategic research often leaves a lot to be desired. On the other hand, the lack of qualitative, conceptual-theoretical approaches to elucidate the somewhat dominant quantitative research, was also pointed out.

APPROACH

In response to these signals the Foresight Steering Committee had a preliminary document drawn up. This study sets several societal issues against potential solutions based on economics research.[1] The reason for this reflection was the dilemma of the need for research regulation and programming on the one hand, and the spontaneous choices which economists themselves make in their research on the other. Discussion of this study at a preliminary conference early in 1995 led to the setting up of the Economics Foresight Committee. It was chaired by drs. R.F.M. Lubbers, the Netherlands' former Prime Minister, currently a professor.

RECOMMENDATIONS OF THE ECONOMICS FORESIGHT COMMITTEE

The Economics Foresight Committee concentrated particularly on the infrastructure for economics research. Societal trends, which could be of relevance for the future direction of this research, were not taken into consideration. The committee regarded possible flaws in the study programmes for economists, and the link between the theory and practice of economics, as important points that required special attention.

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[1] *Dilemma's, sturing en spontaniteit in de economische wetenschap* (Dilemmas, regulation and spontaneity in economics).

The Economics Foresight Committee presented its final report early in 1996.[2] Its recommendations focused mainly on three different fields: the relation between research and education, bringing fundamental and applied research into line, and the market for knowledge in the field of economics.

The relation between economics research and education should, reports the committee, be improved. One of its recommendations was to remove the 'factitious division' between the programmes for economics and those for econometrics and to bring econometrics into the obligatory basic package for all economics students. Students following a researcher programme should also have to spend some time doing practical work in the commercial sector, institutions and ministries.

The Economics Foresight Committee feels that fundamental and applied research in the field of economics should be brought more into line. This could be done, for example, in research programmes and in postgraduate research schools or by setting up combined research teams. The committee argues that the importance of excellent fundamental research for applications should also be taken into consideration when assessing such research. Another recommendation is to allow university researchers to do part-time policy research more often, and to offer part-time professorial posts to experts in the field.

To boost the market for applied research in the field of economics, 'brokers' could be engaged who would help to bring the supply more into line with the demand. Finally, the Economics Foresight Committee calls for quality checks to be introduced for institutions of applied research.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The Foresight Steering Committee feels that the Economics Foresight Committee's report presents a good picture of the current and planned institutions in the field of economics research. Recommendations, such as removing the division between the economics and econometrics programmes and increasing the opportunities for practical orientation in the researcher study programme, have the support of the Foresight Steering Committee. This also applies to several suggestions for improving coordination between fundamental and applied research.

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[2] *Kijk op Economische Kennis* (A View on Economic Knowledge).

Nevertheless, it is regrettable that little attention was devoted in the foresight study to the potential future needs for research in the light of societal trends. The Foresight Steering Committee also finds it a pity that no priorities, in terms of content, were drawn up for the long term. The preliminary document provided some very interesting openings for this; these, according to the Foresight Steering Committee, should be worked out in greater detail in specific research programmes. One of the most important themes is the influence that the aspects of globalisation and regionalisation have on the Dutch economy.

B 23

EDUCATIONAL RESEARCH

BACKGROUND

'Educational technology' was one of the subjects placed on the Foresight Steering Committee's agenda when it was inaugurated by the Minister of Education and Science in 1994. Potential changes also presented themselves in the existing infrastructure of educational research. This was reason to consider a foresight study for the entire field of research.

APPROACH

First of all, the Foresight Steering Committee had an inventory drawn up of the main issues (in terms of subject and projects) in Dutch educational research. Subsequently, a preliminary document was drawn up in which two points requiring attention had been added to the subject of 'educational technology': the relation between fundamental/strategic research and practically oriented research, and how the knowledge chain in this field functions.

The Educational Research Foresight Committee was set up in the autumn of 1994. This committee commissioned various background studies itself and made use of various other studies. It also took it upon itself to examine several scenarios of potentially relevant societal developments in three workshops for the different levels of education. These scenarios, with a time horizon set at the year 2000 and beyond, were apparently not discriminative enough in terms of implications for education to derive any alternative orientations for educational research. The committee did, however, take the ageing working population into account, as also individualisation, the strife towards achieving continually higher education programmes and the advancement of information technology.

FINDINGS AND RECOMMENDATIONS OF THE EDUCATIONAL RESEARCH FORESIGHT COMMITTEE

The Educational Research Foresight Committee were not faced with any structural barriers standing in the way of a healthy ration between fundamental and applied research. Sufficient attention was given to the basic disciplines in the training of educational researchers, and this basic knowledge is passed on well, says the committee.

According to the Educational Research Foresight Committee, there are two comprehensive research themes which require attention. The first is 'learning and teaching', particularly at the level of basic and secondary education. Aspects of this theme are the forming of additional theories on 'investigative learning' and developing a new didactic model. The second theme the committee mentions is 'the effective school'. This relates to (interdisciplinary) research into conditions which have an influence on the results achieved by pupils, stressing the teaching objectives to be chosen, and intensifying the theoretical orientation in educational research.

The Educational Research Foresight Committee also devoted a great deal of attention to the role played by information and communication technology in education. To intensify this role, and to speed up the introduction of information and communication technology in education, the committee argues for:

- striving for processes of change based on an integral vision on the relation between information and communication technology and learning, both in and out of school;
- a substantial contribution made by pupils/students when introducing information and communication technology;
- more stringent control by government given that decentralised decision-making can stand in the way of the large-scale implementation of information and communication technology;
- attention given to information and communication technology in the final terms of the various educational sectors;
- giving financial assistance to small software firms and educational support institutes which develop and introduce information and communication technology in schools.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The Educational Research Foresight Committee performed its task conscientiously. In those cases where the scenarios used turned out to be inadequate for making forecasts it attempted to do justice to the future component in other ways. The emphasised research themes of 'learning and teaching' and 'the effective school' serve to increase an understanding of the learning processes at the start, during and after one's career. This fits in well with the continuous upgrading of the 'human capital' factor. In this context the Foresight Steering Committee finds it regrettable that the report hardly touched upon adult and higher education. Nor did the actual functioning of the 'knowledge chain' in this field of research quite come into its own.

The Foresight Steering Committee would also prefer to have seen an explanation of the role of information and communication technology in education. For instance in those cases where new teaching concepts are concerned which become either possible or essential because of this new technology. For example, informatics probably helps to free up time for the social aspects of the learning process; these social aspects are nowadays becoming increasingly more important. The nature of the research needed for the development and implementation of information and communication technology must also be explained more clearly. This also holds for the effects of information and communication technology in the school and in the classroom. Far too little is known about these effects.

B 24

COGNITIVE SCIENCES

BACKGROUND

There is a growing amount of scientific and societal interest in research in the field of the cognitive sciences. This is research which is of particular importance for various applications and for the use of information and communication technologies. 'Cognition' is a theme which attracts increasing attention in virtually all social sciences; a theme which has links with other disciplines, in engineering and life sciences. Yet there is still a certain amount of concern that existent research structures have been inadequately prepared for achieving good cognitive research.

APPROACH

A preliminary document was drawn up at the Foresight Steering Committee's request.[1] Although this was a document written from a viewpoint of psychology, it also deals with other aspects of cognition. A great deal of attention was given to the potential application of knowledge in this field in different areas.

The document was discussed at a gathering consisting chiefly of representatives of this field of research. It was observed that in the cognitive sciences there is a 'spontaneous integration' of social and scientific disciplines. However, it was also noted that the funding of this research is threatened because of the fall in the number of students in the basic disciplines. The discussion resulted in the decision to start up a foresight study for the cognitive sciences under the auspices of the Social Sciences Council.

POINTS REQUIRING SPECIAL ATTENTION FOCUSED ON BY THE COGNITIVE SCIENCES FORESIGHT COMMITTEE

The Cognitive Sciences Foresight Committee was established in the spring of 1996. Its main task is to monitor the current state of affairs in cognitive science research and to investigate the position of Dutch research in the international dimension. The committee looked at how the research is organised, how the main disciplines are involved and what the relation is with other areas of knowledge. Secondly, the committee wanted to establish how much scientific and societal interest there is for the cognitive sciences, particularly in the light of society's increasing knowledge intensity and the ensuing long-term developments. The final report on the cognitive sciences foresight study is expected in the winter of 1996.

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[1] *Cognitie: wetenschap, technologie en maatschappelijk kader* (Cognition: science, technology and the social framework).

The Foresight Steering Committee sees the importance of this foresight study in the fact that it goes beyond individual disciplines and looks at them as a whole. It also offers more insight into the demand for research in this field in the longer term.

B 25

COMMUNICATION SCIENCES

BACKGROUND AND APPROACH

The potential significance of research in the communication sciences was dealt with in various Foresight Steering Committee foresight studies. For example, 'information and communication' were important themes in the preliminary study into services (B 15), the portfolio study in the field of engineering and the natural sciences (B 17) and obviously in the Informatics Foresight Study (B 04). With a view to the foregoing it was clear that a look at the role of communication science research would also be propitious.

The Foresight Steering Committee commissioned an essay on the communication sciences in general and mass communication in particular.[1] A meeting held in the spring of 1996 was devoted entirely to several dilemmas for research in this field that were raised in that essay.

DILEMMAS FOR COMMUNICATION SCIENCE RESEARCH

The essay claims that the communication sciences contribute towards the design and development of new communication systems. Yet research in this field is also important for the application and utilisation of the (mass) media. In those cases where these media influence people's behaviour and play a role in the transfer of culture, this research should help make those effects evident.

It was the authors' intention to stimulate discussion among researchers about the developments taking place in the field of science. They concluded by setting out what they felt were the four main dilemmas facing communication science research:

- Is it desirable to conduct more fundamental, theory-forming research, or should application-oriented research be expanded even further?
- Is there a certain amount of 'conceptual fragmentation' in the communication sciences, and if so, is it unavoidable, or should we aim towards a better conceptual unity?

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[1] *Wat weten wij over communicatie?* (What do we know about communication?)

- Is there a certain amount of 'organisational fragmentation' in the communication sciences, and if so, is this good or bad?
- Is a greater focus on interdisciplinary research desirable or not?

The essay fails to comment on the quality of communication science research in the Netherlands. Nor are the trends on the demand side discussed.

The Foresight Steering Committee will bring the outcomes of the meeting to the attention of the Minister of Education, Culture and Science, but has decided not to undertake any further activities in this field.

B 26

HUMAN CAPITAL

BACKGROUND AND APPROACH

'Human capital' is the source of all knowledge. In a society where knowledge is starting to count more and more it becomes the main competitive factor. Education and training serve the development and use of this factor; research increases insight into the foundations and effects. Against this background, the report of the Foresight Steering Committee's Working Group on Strategy for the Social Sciences (see also B 27) sees 'human capital' as one of the main multidisciplinary themes for research in the field of the social sciences.

To map out the state of affairs in this field, and to gain an insight into future demands for research, the Foresight Steering Committee commissioned an essay to be written on this subject.

ESSAY AND WORKING GROUP RECOMMENDATIONS

The essay focuses mainly on the theory and empiricism of 'human capital' in literature on economics and the gaps in Dutch research in this field. It stresses the importance of gathering data and underpinning it with figures. Future subjects for research are given as:

- the connection between human capital, knowledge and economic growth;
- gathering figures on investment in human capital by individuals and businesses;
- explaining the low educational output in comparison with foreign countries;
- 'human capital' aspects of the ability to make adjustments and the absorption capacity of the Dutch labour market.

The Working Group on Strategy for the Social Sciences also calls for research to be stimulated in the following fields:

- changes, those already made and those intended, in education and life-long learning;
- developments in the societal demand for human qualities and skills.

FORESIGHT STEERING COMMITTEE COMMENTS

The essay on ‘human capital’ broaches some very essential subjects which we see repeated in many foresight studies in the field of social and behavioural sciences. Intensification of the ‘human capital’ factor calls for societal investments which involve a difficult choice between efficacy and equity.

The Foresight Steering Committee supports the suggestion put forward by the Working Group on Strategy for the Social Sciences to propose ‘human capital’ as one of the integrative programmatic themes for research in the field of social and behavioural sciences. The research themes put forward in the essay are good reference points for this.

B 27

STRATEGY FOR THE SOCIAL SCIENCES

BACKGROUND

After its first interim report towards the close of 1992, the Foresight Steering Committee included 'strategic social sciences' on its agenda as requested by the Minister of Education, Culture and Sciences. The aim was to intensify the role of this field of research in clarifying major societal issues. This aim was confirmed at a broadly organised conference in the autumn of 1993 on 'The Agenda of the Social and Behavioural Sciences'. It was at this conference that the possibilities for programmed collaboration in looking at interdisciplinary fundamental societal developments were discussed.

APPROACH

At the beginning of 1995 the Foresight Steering Committee, in consultation with the Social Sciences Council, the Royal Netherlands Academy of Arts and Sciences and the Netherlands Organization for Scientific Research, established the working group on 'Strategy for the Social Sciences'. This working group was assigned the task of defining those 'steering processes' that (will) influence the general development of our society. It was also required to indicate how the social and behavioural sciences could investigate those processes. The provisional findings of the working group were discussed at a conference held in the spring of 1996. The group's final report incorporated several of the suggestions that were made at this conference.

FINDINGS AND RECOMMENDATIONS OF THE WORKING GROUP ON STRATEGY FOR THE SOCIAL SCIENCES

In its final report the Working Group on Strategy for the Social Sciences defines the 'steering processes' mainly as autonomous developments which have an intense influence on society in many different ways. They set the course for a series of changes in the way society is structured and the way it functions. On the basis of diverse foresight studies and background studies, the working group distinguishes four of theses processes: technology development; diversification of the life course; restructuring the welfare state; and internationalisation of the economy and our culture.

As a follow-up a search was then made for wider research themes which require (from a scientific point of view as well as because of their social relevance) a special research effort and which lend themselves for multidisciplinary collaboration. This resulted in four themes on which the working group felt that societal-steered research programming was both feasible and necessary:

- human capital;
- development of industrial activity;
- social cohesion;
- the environment.

The Working Group on Strategy for the Social Sciences argues that multidisciplinary research programmes on the suggested themes should be brought into an organisation specially set up for that purpose; an organisation with its own budget. The committee gives the following points of departure for such societal-steered programmes:

- the customers and suppliers of knowledge are jointly responsible for the content of these programmes;
- the programmes are provisional and give individual support to senior researchers;
- programmes should contain projects of various sizes and the incorporation of infrastructural, inter-project facilities must also be possible;
- a system of peer reviews and a link with fundamental research funded through the direct and indirect funding mechanisms.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

There is a great need for insight from the social sciences to clarify societal problems. Tending to this need will require more cohesion when formulating the problem and a stronger multidisciplinary approach. The Foresight Steering Committee is of the opinion that the Working Group on Strategy for the Social Sciences has worked out some useful approaches to this end which could also connect up well with the demand for social science research.

According to the Foresight Steering Committee serious thought should be given to setting up several large multidisciplinary research programmes on the themes suggested by this working group. The Netherlands Organization for Scientific Research could play an important role in this context. The essential deepening of social science research will call for additional financial incentives.

B 28

ART HISTORY

BACKGROUND AND APPROACH

The Minister of Education and Science had already set up an Art History Foresight Committee at the end of 1991, shortly before the Foresight Steering Committee started work on its task. This was done at the joint initiative of the professors of art history. This group of professors held the opinion that university research into art history failed to come into its own right as an autonomous discipline.

RECOMMENDATIONS OF THE ART HISTORY FORESIGHT COMMITTEE

The main question to be looked into by the Art History Foresight Committee was how this discipline could best flourish: embedded in wider interdisciplinary links, as an independent discipline, or a combination of the two? The report's main recommendation at the close of 1992 was the call for a single art history research school. This institution has meanwhile been established: the Netherlands Institute for Art-Historical Research.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

In an earlier response, the Foresight Steering Committee had pointed out that the links with the demand side had been given insufficient attention in both the committee's definition of the question and its recommendations. The high level of unemployment among art history graduates and the modest share of research for third parties are by no means insignificant in this respect.

With the above in mind, two conferences were organised in 1993 on the embedment of art history in society. Delegates to these conferences were art history researchers and representatives of museums, television broadcasting companies, publishers, art galleries, organisations involved in the preservation of monuments and historic buildings, cultural funds and the former Minister of Welfare, Health and Cultural Affairs. (N.B.: 'culture' as one of this ministry's areas of policy was transferred back to the Ministry of Education, Culture and Sciences in 1994.)

At these conferences the call was made for a transfer office which would be able to bridge the gaps between fundamental research and research for the art history 'market', i.e. for exhibitions, television programmes, publications, etc. The Netherlands Institute for Art-Historical Research, in which several museums participate, now fulfils a role in this respect.

B 29

DUTCH LANGUAGE AND LITERATURE

BACKGROUND AND APPROACH

Research into Dutch language and literature is essential for the study of our own language and culture. Together with the allied language communities in Flemish-speaking Belgium and South Africa, the Netherlands has a particular responsibility for maintaining the standards of research in this field. The Committee on the Future of the Humanities was given the task of setting out the conditions to achieve this in 1994 (see B 31). Subsequent to this, the Foresight Steering Committee commissioned a foresight study into research of Dutch language and literature in an international comparative perspective. Against the background of this study, plus the work carried out by the Committee on the Future of the Humanities, a strategic conference was organised in the spring of 1996 on the function of Dutch studies.

FORESIGHT STUDY AND CONFERENCE FINDINGS AND RECOMMENDATIONS

The foresight study compared the strength of research in the native languages and literature in Denmark, North Rhine-Westphalia and the Netherlands. The main conclusion was that Dutch research in this field, compared with that in the two other language areas, shows quite a number of gaps and problem areas. For example: formation is only limited, research and library facilities are inadequate and the quality and quantity of digital corpora could be better. There is also a relative shortage of professors in historical and applied linguistics.

The problem areas detected in the study were supplemented at the conference with several recommendations. Language and literature research should give more attention to the demand side and will need to strengthen its ties with secondary education. It was stressed that the government's cultural and political responsibility for this field of research should be expressed in an improvement of the financial conditions. The establishment of a Council for Dutch Studies was also argued, a council which would be able to provide new scientific, societal, cultural and political incentives.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The Foresight Steering Committee feels that this comparative study has painted a good picture of the relative weakness of Dutch research into its own language and literature. A few specialisations have evidently become extremely weak due to successive budgetary measures. This has resulted in some very disconcerting gaps in the actual fundaments of the study programmes.

The Foresight Steering Committee states emphatically that the strengthening of the position of Dutch language and literature is not only the responsibility of Dutch Government but that the research world must also do its share of the work by focusing more on existent societal functions in the transfer of results and in its research. Interesting points of departure put forward at the strategic conference included education in one's own language and literature, the multicultural development and computer-assisted forms of communication.

B 30

MODERN LANGUAGES

BACKGROUND AND APPROACH

In the summer of 1992 the then Minister of Education and Science established the Modern Languages Foresight Committee to advise on research and education in language and literature: Romance and Germanic in particular. When doing so he asked that particular attention be given to any changes in the position and task of the modern languages in the light of European unification and the increasing level of internationalisation.

FINDINGS AND RECOMMENDATIONS OF THE MODERN LANGUAGES FORESIGHT COMMITTEE

The discrepancy between 'societal relevance' and 'societal acceptance' is seen by the committee as *the* core problem for the humanities in general and the modern languages in particular. The committee describes a situation of poverty with regard to research facilities and the amount of research conducted in the modern languages. It formulated themes for research on the basis of the societal functions of this research, whereby the international context plays a significant role.

The foresight committee devoted a great deal of attention to the question whether internationalisation and European unification will not lead to a certain division of roles. It feels that expertise in the field of modern languages cannot simply be contracted or created by purchasing student places for Dutch nationals at foreign institutions. Building up expertise in a foreign language and culture is a form of acculturation which should take place on the basis of one's own culture. This does not mean that student places abroad are not of great value.

The committee names three areas which could be given special attention in the modern languages:

- literature in a cultural context;
- pragmatic-oriented linguistics research;
- historical linguistics research.

The first two are derived from the societal tasks of research, the latter is seen by the committee as an essential gap-stopper in research in the field of the humanities.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The Foresight Steering Committee is of the opinion that the report of the Modern Languages Foresight Committee presents a great deal of very useful information and puts forward some good recommendations, especially those regarding the international dimension. The proposed areas for special attention with regard to the research will need to be latched onto mainly by the research community itself. The report offers little solace with regard to removing obstacles standing in the way of the development of research in modern languages (as well as the other humanities). The Committee for the Future of the Humanities was established with this in mind (see B 31).

B 31

THE HUMANITIES

BACKGROUND

Various foresight activities have taken place in recent years in the field of the humanities and have led to a better insight into the functions of this wide field of learning and the problems it has to deal with. In its second progress report the Foresight Steering Committee formulated three objectives for additional foresight activities in this field:[1]

1. Contributing towards resolving those problems facing the humanities that had been detected in previous foresight studies.
2. Intensifying societal support for this field of learning.
3. Investigating the needs in society for research in the humanities.

APPROACH

The Committee on the Future of the Humanities was set up in 1994 by the then Secretary of State for Education and Science. The committee was given the task of putting forward recommendations in terms of content, organisation and finances for the development of future policy. The committee presented its final report at the beginning of 1995.[2]

The Foresight Steering Committee felt that no new foresight activities into the developments concerning research in the humanities should be started before the effects of the Committee on the Future of the Humanities' final report come within sight. All the more so considering the substantial foresight activities that have taken place in the past few years (see B 28 and B 30). The Foresight Steering Committee did, however, wish to add a new element to the foresight methods used. The Dutch Language and Literature Foresight Study (B 29), which involved a detailed international comparison, was used for this purpose.

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[1] *Koersen op kennis* (Setting course for Knowledge), 1994.
[2] *Men weegt kaneel bij 't lood* (Cinnamon is Weighed by the Dram).

FINDINGS AND RECOMMENDATIONS OF THE COMMITTEE ON THE FUTURE OF THE HUMANITIES

The Committee on the Future of the Humanities placed a great deal of emphasis on the societal functions of this field of knowledge. It made it convincingly clear that the body of thought in the humanities is indispensable as a founding force and source of inspiration for the societies of both today and tomorrow.

"The humanities", writes the Committee on the Future of the Humanities, "are there to support the learning processes between the different communities. Many societies, certainly modern Western societies, tend to set their own values and achievements as the standard for the whole of mankind. The humanities put such leanings into perspective while also respecting them. On the one hand they make our own community respectful by confronting predominant values and achievements with the heritage of our forefathers and that of other communities.
On the other hand they give meaning to the values and achievements of our own community by making them available to future generations and to other communities."

The committee mentions two major problems standing in the way of development of the humanities. First, it suggests that the current funding mechanism leads to a neglect of the actual core of research in the humanities and to unnecessary stimulation of application-oriented study programmes. Second, it sees these developments being intensified through lack of coordination among universities.

The Committee on the Future of the Humanities put forward the following, and other recommendations for the purpose of removing these obstacles:

- Make a distinction between the funding of classical and market-oriented study programmes in the humanities.
- Establish a national chair policy.
- See to the national coordination of library policy.

STANDPOINT OF THE FORESIGHT STEERING COMMITTEE

The Foresight Steering Committee subscribes to the recommendations put forward by the Committee on the Future of the Humanities. However, it observes that in his *Higher Education and Research Plan 1996*[3] concept the Minister of Education, Culture and Science pushes off the responsibility onto the universities. There were two other options:

1. On the basis of his responsibility for science policy and higher education policy, the minister could have made it more attractive for the universities to maintain the 'low student number' humanities within the current funding model.
2. Also on the basis of his cultural and political responsibility, the Minister of Education, Culture and Science could do his utmost to preserve the basis for research in the humanities.

The appeal for the government to honour its responsibility by no means discharges the researchers in the humanities from their responsibilities. In its response to the committee's final report the Foresight Steering Committee supported the recommendations to improve coordination among universities. In this context it advocated taking the organisation of education and research in the language and literature faculties into consideration when working out the proposals. These faculties have introduced new study programmes in response to the smaller budgets and the government's wish to bring university study programmes more into line with the labour market. However, the Foresight Steering Committee observes that the language and literature faculties have made inadequate use of the success of these programmes to preserve the core disciplines. Yet it is these core disciplines that will still have to form the basis for the more market-oriented programmes.

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[3] *Hoger Onderwijs en Onderzoek Plan 1996.*

APPENDICES

Appendix 1

COMPOSITION OF THE FORESIGHT STEERING COMMITTEE

Dr.ir. H.L. Beckers, chairman up to October 1993
Dr. A.D. Wolff-Albers, chair since 1 October 1993
Prof.dr. J.A. van Ginkel
Ir. P.P. 't Hoen
Prof.dr. H.M. Langeveld
Prof.dr. L. Leertouwer
Prof.dr. H. Pinkster
Prof.dr. R.S. Reneman
Prof.dr.ir. G.M. van Rosmalen
Prof.dr.ir. P. Vellinga
Dr.dr. A.P. Verkaik
Ir. K. Vos, since 1 March 1994
Prof.dr. K. Vrieze
Prof.dr. J. Witteveen

Secretary:
- Drs. H.B. Donkersloot

Policy staff:
- Drs. L.M.E.M. Dalderup
- Dr. B.J.R. van der Meulen
- Drs. M.J. Ossewaarde
- Ir. P.A. de Ruijter
- Drs. E.C.M. van Ruyven
- Dr. F.A.J. van Steijn

Secretarial support:
- Drs. I. Van Houten
- E. Kloosterman
- Drs. N.J.F.M. Slegers

Ministry of Education, Culture and Science observers:
- Dr. J. Marks
- Dr. P.A.J. Tindemans
- Drs. M.J.A. van der Varst

Appendix 2

FORESIGHT STEERING COMMITTEE TASKS

The Dutch Foresight Steering Committee was inaugurated by the Minister of Education and Science, dr.ir. J.M.M. Ritzen, on 19 May 1992 as a committee which would have temporary status up to 1 January 1993. This term was extended by a further four years up to 1 January 1997.

According to the Inauguration Order of 19 May 1992 the tasks of the Foresight Steering Committee are:

- to support research organisations by preparing and formulating strategic policy by stimulating the initiation of foresight activities and subsequently supervising them;
- to encourage experimental foresight activities which could grow into a national foresight study agenda;
- to promote integrative activities at national level and to supervise these activities from the foresight process perspective;
- to promote wide-scale accessibility of the results of foresight studies, especially for the government, research organisations and others;
- the Foresight Steering Committee will present the minister with a public report on the results of its duties, outlining the themes and options in preparation of the first Strategic Policy Document and, if the term is extended, the second Strategic Policy Document.

The committee may perform these tasks by:

- consulting with those bodies or organisations which are important for foresight activities, including advisory councils which are important for science policy;
- commissioning foresight activities;
- holding discussions with the minister on a regular basis;
- performing foresight studies itself, or commissioning such studies.

When extending the term of the Foresight Steering Committee, the government also presented it with several subjects for foresight studies. As requested by the then Minister of Education and Science the AWT (Science and Technology

Advisory Council) included a list of fifteen issues in its advisory report.[1] The selection criterion for these issues was that they would require major government decisions in the short term. The minister commented on that list and added two more subjects. The subjects for foresight activities were:

1 mental health
2 energy research
3 agricultural research
4 environmental research
5 production technology
6 microelectronics
7 physics
8 educational technology
9 biotechnology
10 materials research
11 the humanities
12 electrical engineering
13 industrial medicine
14 pharmaceutical chemistry
15 traffic and transport research
16 chemistry
17 human resource management

As it announced in its second report,[2] the Foresight Steering Committee used this as a point of departure on which to base its own foresight agenda.

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[1] *Voorstellen voor de agenda van de Overlegcommissie Verkenningen* (Suggestions for the Foresight Steering Committee's agenda), AWT, July 1991.

[2] *Koersen op Kennis* (Setting Course for Knowledge) Foresight Steering Committee, May 1994.

Appendix 3

THE FORESIGHT STEERING COMMITTEE MATRIX

The Foresight Steering Committee adopted the use of a verification framework for its foresight activities. This framework can best be visualised as a matrix. On the one axis we see the elements of societal demand, i.e. the relationship between research and education and training, sectoral interests and cross-sectoral societal issues; on the other axis we see elements of the foresight process, i.e. what happens in a research field, how might the societal demand develop over the years, what choices can be made, and what activities must be undertaken to implement those choices. Each foresight study also takes international orientation into account, as well as contacts and collaboration with other fields of research. This appendix will attempt to explain the terminology used in this matrix. By filling in each box we get a stratified picture of the present and the future research at the educational, the sectoral and the societal level, the options that exist, and the activities that will need to be undertaken.

	Current situation and trends	Results of scenario analysis	Options	Activities
Education and training				
Sectoral interests				
Societal issues				

Source: *Wat doet de* OCV (The role of the Foresight Steering Committee) – leaflet; OCV 1994: 5.

Education and training

This looks into the extent to which research contributes, or could contribute, towards education and training, so as to ensure a sufficient (future) reservoir of highly trained university graduates and professionals who can be employed in the community or who in turn can undertake high-quality research. This, in fact, covers all the research needed to keep up to date at international level and thus ensure the quick absorption of breakthroughs elsewhere.

Sectoral interests

Analysis of how research can contribute towards the functioning and the innovation capacity of the profit and non-profit sectors of our community. These sectors cover not only economic activities but also include public administration, justice, the police, the health service, cultural activities, infrastructure, etc. In addition to scientific quality, this research is also assessed on its possibilities of application.

Societal issues

Societal issues, such as the sustainability of society, environmental issues, population composition, shifts in norms and values, etc., go beyond the interests of one or several sectors. This criterion looks at whether research is able to contribute towards the quality of society in the future. The nature of the problems to be resolved is often multidisciplinary and international.

Current situation and trends

A description of the state of the art in a certain field of study or discipline and both current and foreseeable trends. The state of the art generally involves an analysis of the strengths and weaknesses.

Scenario analysis

Future scenarios offer an outline of those social trends that are important for a certain field of research. An analysis of the longer term leads to a greater understanding of the possibilities and the consequences of science and technology. See also Appendix 6.

Options

A description of the options in a specific field, based partly on an analysis of the strengths and weaknesses of the Dutch contribution and of the scenario possibilities.

Activities

Decisions on the options that have been formulated will lead to government activities and activities undertaken by research organisations or users, e.g. formulating the priorities or indicating areas which require special attention.

Appendix 4

EXPERIENCES WITH THE FORESIGHT STEERING COMMITTEE APPROACH

Today there is very little discussion held in the international dimension on the necessity to steer the major public research efforts by means of foresight studies. Whereas intensive experiments have been carried out in many OECD countries it has still not led to a standardised approach. After all, the quality of foresight studies cannot be deduced from the extent to which a limited number of methodological starting-points are used, as can be done in the case of research. Given that foresight studies must lead to *changes* within a national research system, they must be attuned to the inherent disposition of that system. Foresight has consequently been described as a 'balancing act': between top down and bottom up, as well as between technology push and demand pull (Martin 1995).

The question of success or failure of the Foresight Steering Committee approach should therefore be set in the specific Dutch context. And that is a strongly *decentralised* public research system with players accustomed to a considerable level of latitude, coupled with a relatively weak top level and ever-decreasing means of control. This reveals itself in the twofold assignment given to the Foresight Steering Committee: on the one hand to present the government with options for the decisions they must make, while on the other hand to drag the many players and interested parties along, and to get their commitment. To what extent has the method chosen by the Foresight Steering Committee proved suitable?

ACHIEVEMENTS

First of all we can state that the matrix (which in actual fact is the very essence of the Foresight Steering Committee approach) is evidently a very powerful tool in starting up discussion between both the supply and the demand side, with an open mind to the future. The matrix applies a minimum amount of structure to the complex supply and demand problems inherent in research; this facilitates the discussion considerably and promotes the identification of real possibilities for improvement. At the same time we should establish that in itself the matrix is not yet a tool: in all fields will the general terms of 'education and training', 'sectoral interests' and 'societal issues' (see Appendix 3) be operationalised further, preferably by relevant experts and foresight experts together.

Secondly, we can also state that the newly developed course of the process, in which those concerned are consulted as to the use and structure of a foresight study as early as the *initial stages*, has turned out to be spot on. This has led to foresight activities being started with a specific focus and to foresight studies which have attracted a great deal of attention in the field concerned. Both are extremely important for the effects of the results.

Thirdly, we may establish that the introduction of working with *scenarios*, as an instrument of foresight to map out the future *environment*, has led to foresight studies being focused more on the threats and opportunities in the long(er) term. This is important for two reasons. First of all, there is still time to prepare for longer term threats and opportunities, implying that the players must use their own means of control and form new coalitions; the latter leading to a relativisation of the short-term interests. Secondly, it makes the differences in time horizon between the supply side and the demand side (a well-known problem in the dialogue between the two) easier to discuss. The research sector takes the lead within the government with regard to the use of this instrument, intended specifically for learning how to deal with the *un*certainties of the future.

Finally, it is evident that many players are willing to contribute, in terms of time spent in meetings, manpower and finances, towards foresight studies which are relevant in their own particular case. The Foresight Steering Committee is pleased with the cooperation and enthusiasm its initiatives met with over the years; this is reported on for each field of research in Section B. The efforts of those concerned are reason for the Foresight Steering Committee to have faith that the results of the foresight studies will indeed have a productive effect in setting out strategy on all levels of the research world. It concludes that the future is of interest to us all, and that the efforts needed to obtain an insight into that future are easy to share out, at least if there is a player willing to take the initiative to do just that.

These achievements do not alter the fact that there is still a great deal to learn about, and improve, certain elements of the Foresight Steering Committee's approach. Some of the essentials will be dealt with in the following; some tips on how to use the scenario approach are given in Appendix 6.

SUPPLY AND DEMAND

Once again, the Foresight Steering Committee foresight studies have shown how great the differences in terms of culture, time horizon and availability can be between representatives of the supply side of research and those of the demand side. Working alongside one another in a foresight committee is not always enough, and it would seem that different kinds of discussion/ information are sometimes needed to do justice to both sides. In that case, a foresight committee tends to become more like a steering committee which has to agree on the approach to be taken, rather than a board of experts; the actual execution is subsequently contracted out and examined upon delivery.

It also appears that the demand side often manifests itself through other disciplines: i.e. the role of science subjects and social science studies where mathematics are concerned, or the role of the technical and life sciences in physics. This must consequently be made a permanent point of focus for foresight studies.

Where the supply side is concerned, current foresight studies often lack adequate estimates for the longer term. Since future scenarios focus on the *surroundings* of research, i.e. primarily on the demand side, it becomes essential to predict the internal dynamism of science and technology. This can be done by making use of existing Delphi studies which focus on that dynamism, or by surveys held by the foresight committee itself.

Nevertheless, the differentiation made here between the supply and demand sides of research is gradually disappearing in the stages leading up to a *knowledge society*. The acquisition of knowledge is becoming a part of the productive processes; at least interacting very strongly with them. It would therefore seem essential to choose a perspective for future foresight studies which is wider than the development of strategy for (public) research: attention must be focused on the innovation processes as a whole in any societal sector or problem area.

SCENARIOS

The Foresight Steering Committee has succeeded in taking working with scenarios and converting it into a mini-exercise; an exercise which is quite feasible within the limited time available for a foresight study. Qualitative techniques have proved adequate to make relevant scenarios of the surroundings. Especially towards the end of a foresight study do these become useful for checking, at workshops together with those concerned, whether the provisional conclusions drawn by foresight committees will hold good in the future. Scenarios are a useful but by no means easy instrument to use for science and technology foresight studies. It is necessary to build up experience systematically. More latitude will need to be created specifically for this in a future foresight set-up.

COMMITTEE AND SECRETARIAT

Foresight committees not only have the task of searching for facts and organising them, they are also expected to come up with options. This implies (the need for) *processes of negotiation* in foresight committees. In addition to the differences in point of departure, in composition, and in the focus of different foresight studies, this often gives rise to a strong, internal dynamism. However, this can interfere with the technical requirements that must be set for a foresight study and can lead to lengthy, detailed involvement of foresight committee members with methods and collection of data, resulting in a shortage of time and a lack of sufficient funding or in the omission of essential components. This dynamism puts a very heavy responsibility on the secretary.

There are several ways to cope with this problem. The main thing is to bring about a clearer distinction between the methods and process progress on the one hand (which should be established through the efforts of external foresight expertise) and the interpretation and evaluation of results on the other (which must obviously be done by the foresight committee members themselves). Appropriate in this context is the contracting out (in part) of the scenario analysis, thus avoiding the need to invent at least this wheel every time. A better distinction between methods for generating ideas and strategies on the one hand, and methods for selecting and weighing them on the other, can also help. Foresight committee members will need to commit themselves to this approach when accepting a position on the committee.

COMPARATIVE JUDGEMENTS

The Foresight Steering Committee approach, which is characterised by *exhaustive* foresight processes in a relative *limited number* of areas, lends itself well for widely supported opinions in the various fields of research. However, this approach does not immediately present the appropriate data for making comparative judgements between the different fields of research given that the results are not all-embracing and all have a different 'shelf life'. The Foresight Steering Committee has therefore experimented with appending specific activities to the data which focus less on depth and more on breadth, something which is also necessary to be able to make a sound choice of areas to be subjected to foresight studies. It would seem feasible to use this to build up a picture which supports global comparative judgements, at least between fields and disciplines *in which there is a certain amount of cohesion.* The Foresight Steering Committee looked at the wide fields of the technical and natural sciences, medical sciences, the behavioural and social sciences and the humanities. This will need to be worked on further in a successive term of foresight.

No objective foresight methods are available to draw comparisons between fields of research in which no demonstrable cohesion is to be seen, for example: between astronomy and economics or between the humanities and health research.

EFFECT

At this moment there is little data available on the actual *effect* of Foresight Steering Committee foresight studies. Yet even now we can establish that this aspect must be given a great deal of attention since the story is by no means finished when the Foresight Steering Committee presents its options. Not only will a choice then need to be made, but even after that will an intensive implementation stage be necessary in order to allow the more radical changes to take effect. Those choosing from the options, and in many cases that will be the government, must assign specific responsibilities with regard to that implementation.

Subsequently, there will need to be some form of regular monitoring to ensure that the agreements that have been made are observed and, where necessary, to adapt them to suit the changed circumstances. Given that this coincides with the decision to restart foresight activities, either in the same or an adjacent field, it would seem only obvious to charge the future foresight organisation with this monitoring task.

Appendix 5

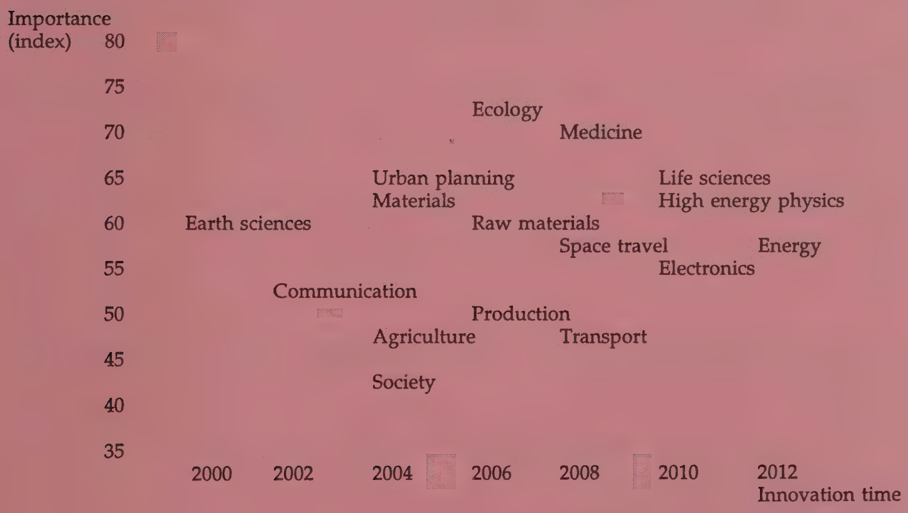
INTERNATIONAL EXPERIENCES WITH FORESIGHT ACTIVITIES

The experiences of the Foresight Steering Committee with foresight activities are in line with the international experiences. In many countries, foresight activities were carried out in the early nineties as an instrument for science and technology policy. The most important driving forces behind this were the identification of *emerging technologies* and the setting of national priorities.

Following in the footsteps of Japan, Delphi studies were then carried out in Germany and France. These studies required scientific and industrial experts to predict when certain technological options would become feasible, what would be the significance of these options, and what are the main obstacles. This involved a total of 1,150 questions divided among a total of sixteen different fields of study. Delphi studies can give a good insight into the views experts hold as to which technological developments might possibly take place over the next twenty years. The figure below shows the average level of importance attributed to technological options and when they will become feasible.

FIELDS IN THE GERMAN DELPHI STUDY

Average level of importance versus time required for innovation



Source: BMFT, *Deutsche Delphi-Bericht zur Entwicklung von Wissenschaft und Technik*, Bonn 1993.

The results of a Delphi study do not lead directly to priorities or recommendations for policy. Setting up and executing a Delphi study requires the involvement of a large number of experts to contemplate potential technological developments and the possibilities and obstacles that stand in their realisation. The results are thus background material that can be used to develop strategy for research organisations, governments and trade and industry.

Foresight processes have been carried out in England and Australia in which, similar to the situation in the Foresight Steering Committee, a strong focus was placed on the work of panels. This resulted in the studies being more strongly embedded in the research system's strategic processes than is the case if Delphi studies are used. In addition to the more broadly-based technology foresight in Australia, five partnerships have also been formed there to research the future in specific groups and formulate the consequences for science and technology. Several background studies were carried out and disciplinary strategies were also worked out in more detail for the earth sciences, chemistry, educational research, physics and astronomy.

ASTEC FORESIGHT STUDY – Australia
Focus of Partnerships

1 *Urban water life cycles*
the provision of adequate and safe water in urban environments in an environmentally sustainable way
2 *Information and communications technology*
futures for broadband interactive networks
3 *Health*
neurodegenerative disorders of the aged
4 *Shipping*
maritime futures for Australia
5 *Youth*
preferred and expected views of the future

Source: ASTEC, *Key issues for Australia 60 2010*, ASTEC Canberra 1995.

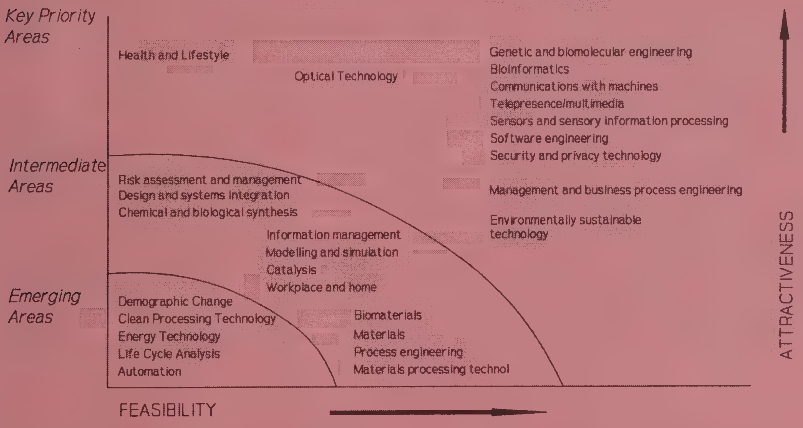
The foresight process report sets out priorities based on the four driving forces of progress in Australia:

- information and communications technology;
- the environment;
- genetics and biotechnology;
- globalisation.

Probably the most extensive and penetrating foresight study to date was the *Technology Foresight* carried out in England. As part of a reorientation exercise in science and technology policy, this foresight started up discussion among researchers, industry and the government on the anticipated trends in science and technology and on the strategies to act in anticipation thereof. It was a study in which several methods were combined. Under the supervision of panels, Delphi questionnaires, regional discussions and other consultation procedures were held systematically in fifteen different fields. The fifteen reports were then used by the steering group to draw up a portfolio of emerging priority technologies.

RESULTS OF TECHNOLOGY FORESIGHT

Generic priorities in science and technology


Key Priority Areas
Health and Lifestyle
Optical Technology
Genetic and biomolecular engineering
Bioinformatics
Communications with machines
Telepresence/multimedia
Sensors and sensory information processing
Software engineering
Security and privacy technology
Intermediate Areas
Risk assessment and management
Design and systems integration
Chemical and biological synthesis
Management and business process engineering
Environmentally sustainable technology
Information management
Modelling and simulation
Catalysis
Workplace and home
Emerging Areas
Demographic Change
Clean Processing Technology
Energy Technology
Life Cycle Analysis
Automation
Biomaterials
Materials
Process engineering
Materials processing technol
FEASIBILITY
ATTRACTIVENESS

Source: OST, *Progress through Partnership*, Report from the Steering Group of the Technology Foresight Programme, HMSO, London 1995.

Appendix 6

WORKING WITH SCENARIOS

WHY SCENARIOS?

Scientific research is work which demands patience; it seldom comes up with instant results. Several decades might easily pass by before society is able to pluck the fruits of that work in the form of new technology, for instance. Science and technology policy is not geared towards today's needs for technology or today's supply of knowledge, but rather to that of tomorrow and the day after. Experience in mapping out the potential knowledge supply in the somewhat longer term has been gained internationally: Delphi studies, lists of emerging technologies and the like. Researchers or technologists are therefore accustomed to thinking in terms of the longer term. This is usually the opposite on the demand side, where people would rather have an immediate reply to their urgent questions and needs. An extra creative efforts is called for to get the long term on the agenda of the demand side. This is necessary to be able to articulate the future needs for knowledge so that the supply side can take it into consideration. One method the Foresight Steering Committee chose was to work with scenarios. To avoid terminological misunderstandings we are referring here to alternative models for the future surroundings of research.

The Foresight Steering Committee's experience with scenarios in the fields of agriculture, chemistry, computer science, law, educational research, health research, earth sciences, research into nature preservation, energy research and traffic/transport/infrastructure research, present a multiform picture of the potential use of scenarios in science and technology policy. The Foresight Steering Committee deliberately gave the foresight committees sufficient latitude to adopt different work procedures and interpretations.

ADVANTAGES

One of the main advantages of working with scenarios has turned out to be that they can help get the long-term needs for research placed on the agenda; they can also help in getting beyond the short-term interests. Secondly, working with scenarios helps to broaden the strategic discussion about what the future holds in store for a certain field of science. The participative character of scenario workshops, in which the supply and demand scrutinise one another with a view to the future, boosts a sense of involvement in a foresight study. The individual participants can also use the scenarios to help them form their own strategies. Several institutes have already used or incorporated the Foresight Steering Committee's scenario method in their own methods of approach.

For any scenario exercise to be successful, certain aspects must be given serious thought:

Methodology

Drawing up alternative scenarios for the long-term environment of the research necessitates a strict methodology. This suggests contracting out the scenario work to foresight experts whenever possible. The task of (re-) writing the scenarios is far too time consuming to be done by the foresight committee members themselves. Luckily, this is not necessary as scenarios are simply the instruments and not the ultimate objective of the foresight. However, what is essential is the foresight committee members' resolute involvement in drawing up a list of the *uncertainties* and in selecting scenario *cores*.

Custom-made scenarios

Scenarios must contain unexpected elements that lead to stimulating and innovative discussion. Yet at the same time, the scenarios must be 'recognised' in the field of research for which they are intended. This implies that newly developed scenarios, custom-made for the field in question, will generally be given preference.

When

Experience gained from Foresight Steering Committee foresight studies show that scenarios are generally more useful as the criterion for selection, i.e. at the end of a foresight study, than as a means of generating research strategies at the beginning of the study. After all, these strategies will usually be available already, thanks to the 'natural' long-term perspective of researchers.

Three stages

When working with scenarios we can generally distinguish three separate stages:

1 *Uncovering and grouping the uncertainties*

Uncovering the *un*certainties will add to what we often already know about the future. However, clarifying uncertainty, and taking uncertainties into account, can sometimes be contrary to the habits of researchers and those requesting the research. Interviews or brainstorming sessions with key experts have proved to be good methods for uncovering these uncertainties reasonably quickly. They can then be grouped in a figure with two dimensions: *impact* (the importance for a field's research strategy) and *uncertainty* (the extent of doubt as to their probability).

2 *Drawing up the scenarios*
First of all a choice is made as to which key uncertainties the scenarios will revolve around. The other uncertainties are then grouped around these uncertainties in a logical fashion until coherent alternative scenarios emerge. The cohesion between these uncertainties is important for internal consistency, and thus for the credibility of the scenarios. It is also important to take care in writing the scenarios: after all, they will need to 'come alive' for the users.

3 *Linking scenarios with research strategies*
This is done preferably during 'scenario conferences' attended by representatives of the supply and the demand side in a particular field of science. After all, scenarios are not a goal in themselves. Ultimately, the main aspect will be the implications for the direction the research is to take. The confrontation between the scenarios and the (intended) research will indicate the extent to which that research will be relevant in the future too, in which areas new research themes present themselves, or which themes will always be important in any scenario. Scenario conferences, organised simply and focusing directly on discussing scenarios and their consequences in small groups often generate the best results.

Appendix 7

THE MOONSHOT APPROACH

The Foresight Steering Committee holds the opinion that an experiment with a moonshot approach is an attractive proposition for coordinating science and technology. In this context moonshot means *mapping out the need for knowledge with regard to an important societal project, and checking out the extent to which that knowledge is available, or can be generated, in the Netherlands.*

A moonshot approach is useful for substantial challenges in the medium and long term. It offers a means of adjusting the cycle of knowledge generation and of establishing a connection between that cycle and the innovation cycle. It offers the advantage of being accessible to a wide public, which sees a direct link between the social issue and the necessary investments in knowledge, plus the fact that it provides the opportunity to sound out an entire network of interrelated fields of knowledge and use it for a common challenge.

The desirability to experiment with a moonshot approach also came to the fore in various discussions between the Foresight Steering Committee and representatives of societal organisations. F.M. Roschar was subsequently commissioned to map out the possibilities. The following criteria were referred to in his report:[1]:

1. a strong Dutch interest;
2. the project calls for potential breakthroughs in science or technology and therefore cannot be executed at present;
3. the project is feasible from the scientific point of view.

Several examples of projects that lend themselves for a moonshot approach have been traced by making use of already available social trends analyses and Delphi studies for potential technological/scientific breakthroughs. A reduction of up to 50% on primary energy consumption was one of the fields in which a moonshot approach could be used. Further concretisation could be the large-scale introduction of direct current, the so-called 'all-DC electric society'.

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1 *Identificatie van maatschappelijke projecten die zich lenen voor een Moonshot Approach* (Identification of societal projects which lend themselves for a moonshot approach).

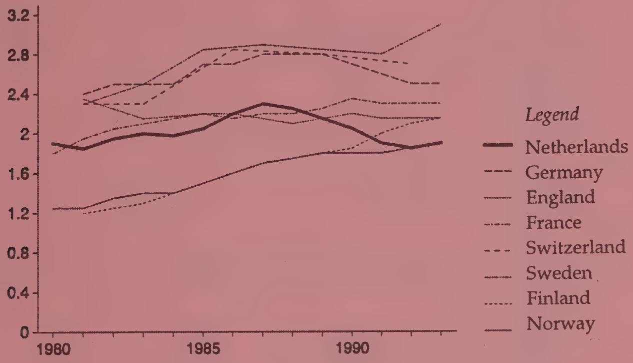
Other fields which the Foresight Steering Committee considers eligible are: the Netherlands, the most efficient gas economy (see also Section B 09 Energy Research); doubling the standard of living and cutting the environmental costs by half (Factor 4; see also Section B 07 Environmental research and research into nature preservation); building cheaper underground (see Section A § 2.3); the Netherlands, Software Nation (see also Section B 04 Computer Science); and suchlike. For that matter, the work of the Interdepartmental research programme Sustainable Technological Development (DTO) also contains moonshot approach elements.

The Foresight Steering Committee is considering whether to use the moonshot approach as one of the instruments for science and technology policy. The background study that has been drawn up at least makes it clear that there are numerous areas in which such an approach could contribute towards analysing the needs for knowledge in society.

Appendix 8

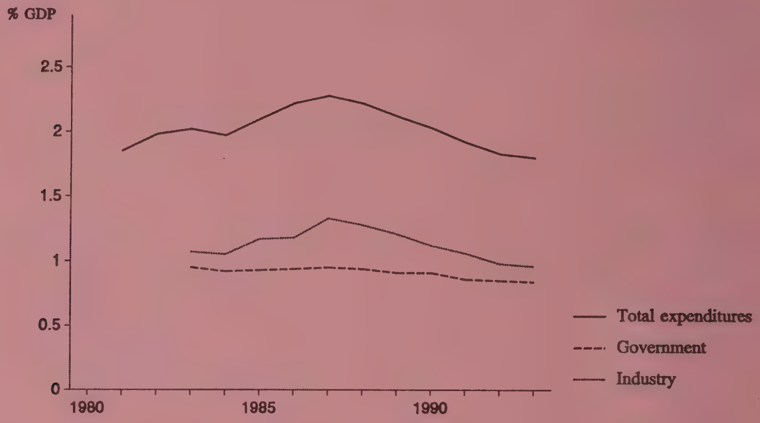
RESEARCH EXPENDITURE

The trend in Dutch research expenditure in GNP in comparison with other nations (in %)



The European Report on Science and Technology Indicators 1994, *European Commission*, October 1994. Expenditure in MECU 1987 US prices.

The trend in research expenditure in the public and the private sector as % of GNP



The European Report on Science and Technology Indicators 1994, *European Commission*, October 1994. Expenditure in MECU 1987 US prices.

Trends in government research expenditure according to areas of application

	1987	1990	1993	1994	1995	1996 draft	2000 estimate
1 Exploration and exploitation of the earth's environment	27,0	32,3	15,9	15,8	16,9	15,7	15,0
2 Infrastructure and physical planning policy	220,6	225,3	233,2	209,0	216,5	208,3	174,1
3 Environmental pollution	159,8	186,1	225,0	217,1	188,6	178,2	155,6
4 Protecting and improving human health	126,9	157,7	134,4	103,7	104,3	104,5	104,4
5 Energy research	196,6	156,0	157,1	172,2	156,5	174,8	210,1
6 Agricultural research	206,9	227,8	260,4	252,5	238,0	245,6	222,7
7 Industrial productivity	861,1	1.156,2	655,5	638,1	622,3	611,1	604,4
8 Social structures and relationships	120,1	116,5	122,5	117,8	124,9	121,2	121,6
9 Space research	135,0	130,6	198,0	211,3	213,5	222,4	174,9
10 University research (1st flow of funds)	1.915,8	1.567,0	1.834,9	1.999,2	2.081,7	2.066,4	2.147,9
11 Non-application-oriented research	498,8	541,9	572,0	580,1	606,0	602,2	621,8
12 Other civil research	219,4	190,4	276,2	296,4	309,3	308,5	336,0
13 Defence	136,4	158,8	165,8	176,9	162,1	166,8	153,4
Total	4.824,3	4.846,6	4.850,9	4.990,1	4.990,1	5.025,7	5.041,9

Source: Ministry of Education, Culture and Science

Appendix 9

PUBLICATIONS IN ENGLISH

The following list gives an overview of publications in the English language (some of which are translations). The Dutch version of this report contains a complete list of publications, those published by the Dutch Foresight Steering Committee and those by other organisations. However, the majority of these publications are only available in Dutch.

Compass and Telescope: a framework for foresight activities in the field of science and technology – Foresight Steering Committee Report; OCV, October 1992.

Setting course for knowledge – Foresight Steering Committee Progress Report; OCV, May 1994.

The role of the Foresight Steering Committee – brochure; OCV, August 1994.

Foresight in Science and Technology, B.R. Martin, in: *Technology analysis & strategic management*, Vol 7, No. 2, 1995.

Heterogeneity and co-ordination: the experience of the Dutch Foresight Steering Committee, B.J.R. van der Meulen, in: *OECD Science Technology Industry*, special issue on government technology foresight exercises, review No. 17, 1996.

A technology map for Dutch business (+ executive summary); Arthur D. Little, February 1996.